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AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 14, No. 20. WEEKLY. | NEW YORK, THURSDAY, MAY 14, 1891. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

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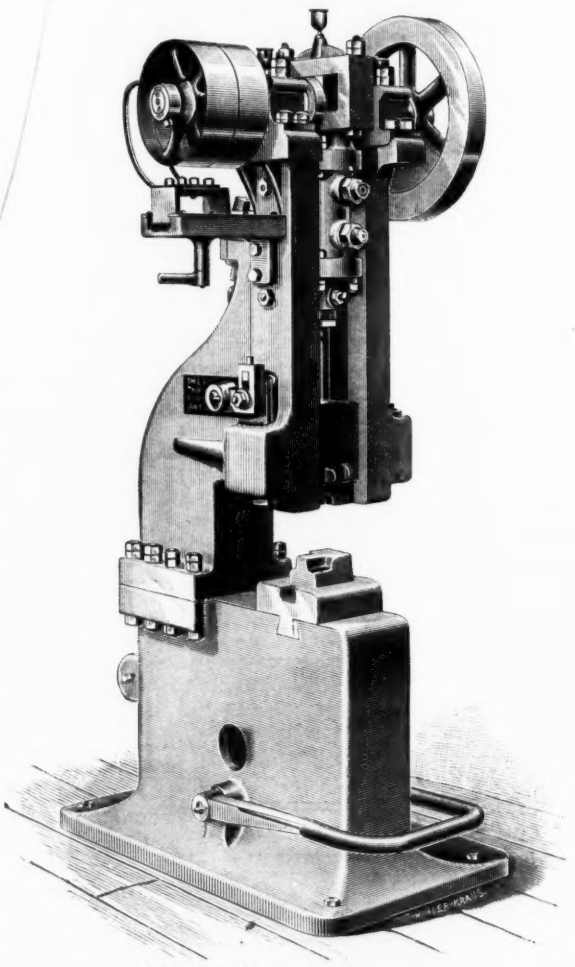
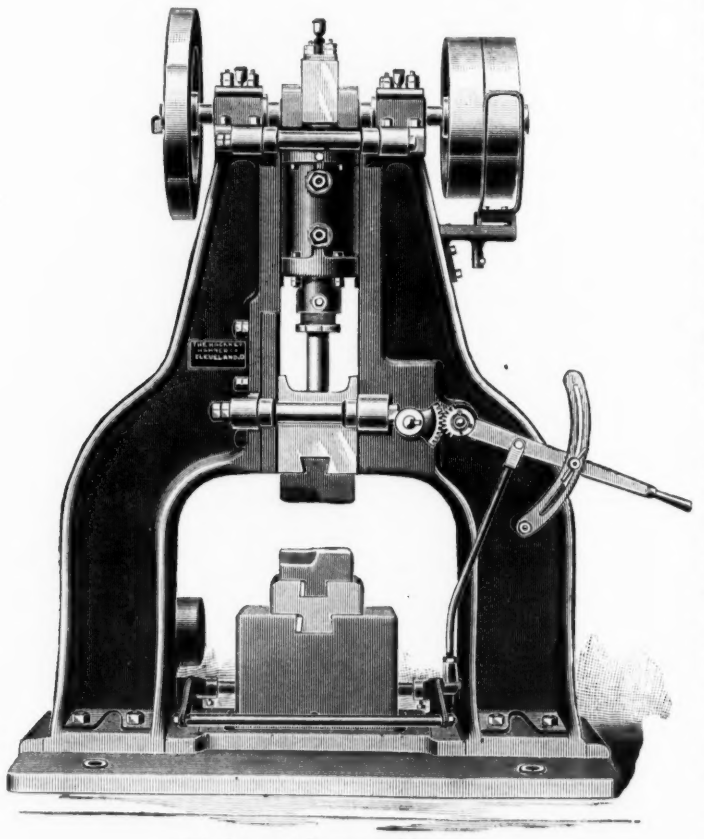
The Hackney Power Hammer.

We give on this and the succeeding page some illustrations of a new power hammer, which embodies some points of interest to hammer users and mechanics generally. The hammer is of that class known as pneumatic; that is to say, it is driven by a belt, but air is used as a medium by which motion is transmitted to the hammer head, as will be explained further on.

Our illustrations show two different styles of the hammer, the single and the double standard, the latter style being adopted for the larger sizes only, and the mechanism and method of working being practically the same in each. At the top of the standards there is a forged-steel crank-shaft working in bearings of phosphor bronze, one on each side of the crank. The crank works in a yoke, having a sliding box of phosphor bronze, this yoke being attached directly to the air cylinder below, which is thus given a vertical reciprocating motion in the slides formed in the standards. Within this cylinder is a piston, which, by the usual rod, is attached to the hammer head, the air, more or less of which is confined above and below the piston, serving to transmit motion to it and to cushion it at the end of each stroke.



50 POUND HACKNEY HAMMER.



300 POUND HACKNEY HAMMER.

The admission and confinement of air in the cylinder is controlled by valves, which may be worked by hand or foot, as is most convenient, these valves, and the method of controlling them, being shown by the sectional and outline views, Fig. 3 (page 2), in which an enlarged section of the cylinder is shown at the left. In the larger sizes of hammers there are four valves, as shown, and designated *a*, *b*, *c*, *d*, the two last named being merely admission valves, which admit air to supply the place of what may be lost in case there is any leakage. This, of course, they accomplish automatically and at each stroke, so that any reasonable amount of leakage does not interfere with the working of the hammer, and the piston and stuffing-box need not be so tight as to interfere with free working. The valves at the back of the cylinder *a* and *b* are the ones by which the motion of the hammer is controlled, these valves being opened and closed by means of a sliding wedge, which is connected to the system of levers before referred to, and clearly shown on the outline view, Fig. 3. These valves open in reverse directions, so that when one of them is opened by the wedge the other is closed. Valve *a* being closed, or, the tension upon the spring which tends to close it being increased by the action of the wedge, the air is confined above the piston, which is thereby forced down, valve *b* being at the same time opened, so that, until the piston has passed this valve, its motion is unimpeded.

After passing valve *b*, however, the air confined below this point has no means of escape, and is compressed, forming a cushion and serving to raise the piston after the blow has been delivered.

It will be understood, however, that the action of the air, its compression, etc., depends upon the relative motions of the piston and cylinder as much as upon the absolute motion of either, while the intensity of the compression, and consequently the force of the blow delivered, depends upon the degree of opening of the valves *a* and *b*.

The motion of the hammer is considerably greater than that of the cylinder, and the action of the valves is so prompt and certain that a single blow can be delivered with the maximum force, and the hammer will be arrested and held at the upper end of the stroke by a brake provided for that purpose, which is controlled by the same lever that operates the valves. This enables the hammer to be used for drop forging simply by putting in suitable dies for that purpose, and without any other special preparation whatever.

The guides for the cylinder and hammer head are adjustable for wear, and can easily be replaced. In the smaller sizes the lower part of the hammer, upon which the die block rests, is made separately, so that it may be easily renewed in case of breakage, while all the larger sizes have separate anvil blocks, which are arranged to rest upon their own foundation, as shown by the outline cut

As explained in our editorial correspondence (issue of April 30), the method adopted in the manufacture of these hammers is such as ought to, and, we believe, does, secure workmanship of the best character, with all the advantages of interchangeable parts, which can be supplied at short notice. They are regularly built in six sizes, ranging from 50 to 500 pounds, the nominal size of the hammer being the weight of the head, rod and piston. The 50-pound hammer weighs 2,500 pounds; stands 6 feet 2 inches high over all; has 7 inches travel of head; uses dies 5½ inches long; is driven by a 3½-inch belt running on a 10-inch pulley, and will deliver 350 to 380 blows per minute. The 500-pound hammer weighs 14,000 pounds; stands 8 feet 5 inches high over all; has 14 inches travel of head; uses dies 14 inches long; is driven by a belt 5 inches wide running on a pulley 24 inches diameter, and can strike 200 to 250 blows per minute. The hammers are built by the Hackney Hammer Company, Cleveland, Ohio.

The mercurial pressure gauge extending from the bottom to the top of Eiffel Tower has been completed. This is considered a notable achievement, as it enables pressures to be measured up to 400 atmospheres by a mercury column. The tube is of mild steel, something more than ⅛ inch inside diameter. In order to note the height of the mercury in the steel tube, glass tubes are located at intervals beside it, and are provided with cocks communicating with the steel tube.

Letters from Chip.

Mr. Editor:

Birchall was one of those born mechanics we have heard so much about lately; he wasn't one of those chaps who think they are geniuses, and disdain the ordinary means of improving their natural endowments; who build windmills and water-wheels when of tender age, and design impossible machines when they come to riper years. No, Mr. Editor, Birchall was not of this class; but he was a born mechanic, and his inherited mechanical ideas had been supplemented by a good training in the old machine shop where he was apprenticed, and afterward in the two or three modern shops where he went to work as a jour.

At the time I met him, Birchall was superintendent of a concern building small engines and special machinery—an expensive combination—but he seemed equal to the occasion, and the firm was making money. As I became better acquainted, I found Birchall was also chief draftsman, although he never took time to draw anything more elaborate than a pencil sketch; but every stroke of these sketches had an idea in it. Did you ever notice that natural mechanics were almost always handy with a pencil?

If a new machine was to be built, a pencil sketch containing leading dimensions was given to the draftsman, who laid out the different views of the machine, generally full size. During the progress of this work Birchall would suggest changes in shape and size, and, when finally completed, working drawings would be made for shop use—all parts being scaled down so as to make one of two sizes of cards convenient for handling.

In connection with this designing I noticed our born mechanic used no rules or books; he simply made the parts so they would look right, and to him, if a thing looked right he did not have to make it "three times as strong as nice," as did our German friend of an earlier date. As an aid to having things look right, they were drawn full size, as the eye can better appreciate the relative size and strength of parts when they are not reduced. Realizing the importance of a proper conception of size, Birchall had nailed up against the walls of the drawing-room two or three strips of wood (about six inches wide and long enough to extend from floor to ceiling), which were painted black and divided by clear white lines into feet and inches, the scale being marked every three inches with plain figures, which were large

enough to be seen from any part of the room. Another convenience in this drawing room was a large slate about five feet by six, which was permanently divided into inch squares scribed on its surface, and so arranged that it could be readily raised or lowered. The use of such a piece of drawing-room furniture is a great convenience, even to a born mechanic, who is generally supposed not to do any preliminary sketching; not so, however, our born mechanic; for Birchall spent many an hour standing before this slate, working out his ideas and proportioning some new machine. His pencil sketches were made from this preliminary work, the leading sizes being directly obtainable from the marked squares. I noticed that our friend used a soapstone pencil similar to that used by some boiler makers when laying out sheets; it gave a finer line than chalk, and was much more agreeable to handle, as there was absolutely no dust.

Birchall had a good eye for symmetry, and his designs always looked well, but what was more to the point, the different parts of his machines were never known to be too weak, and yet you couldn't pick out a single piece and say it looked too large or clumsy. In his pencil sketches he would indicate the diameter of shafts or screws to be used in a given place, and rarely were they altered. He got up two or three sizes of portable agricultural engines at one time—nothing fancy nor remarkable about them, unless we include the method of proportioning, which was altogether a matter of judgment. Of course, certain sizes were fixed from their relation to other parts, but the innumerable details had to be assumed.

The thickness of cylinder walls, and the diameter and number of studs, for instance, were wholly matters of judgment with Birchall.

* * * * * * *

A new draftsman, one of those college chaps, Thompson by name, had recently come into the employ of the firm, but things seemed to go on just the same as usual—Birchall made his sketches and Thompson worked them up as was previously done, using the sizes given.

* * * * * * *

A great event had happened: Birchall had gone off for a month's vacation—the first time in nine years. Shortly after he left, an order came in for an engine larger than any that had ever been built in the shop, and the firm didn't really know what to do—whether to refuse the order or recall Birchall. Drawings and patterns must be gotten out, and to wait for Birchall's return was out of the question. Our college chap here proposed to get out the drawings alone, and with many misgivings on the part of the firm, as to the result, he was allowed to go ahead.

Thompson wasn't much of a practical fellow; that is, he didn't have very much personal experience in running machines; he had worked a little in the shop during vacations, and was not entirely unfamiliar with tools, but the bulk of his mechanical knowledge had been acquired by study and observation, which latter had not been confined exclusively to the machine shop. He could tell how a pattern should be made and molded, and knew lots about coring; he could tell you how to forge a socket wrench to the best advantage, and how to build up a locomotive frame; he knew that an outside square corner on a forging cost lots more than a plain bend, and should be left out of his design, if not essential; he also knew that standard sizes were in vogue in the machine shop, and that a stud ¾ inch in diameter answered every purpose just as well as if it had been 0.765 or 0.732 inch in diameter. All this Thompson knew, and he had confidence in his knowledge. He differed from the practical Birchall, in that he was confined to rules and tables for his dimensions, but in this he had learned that all rules are more or less elastic—they can be stretched, if circumstances seem to warrant it. The thickness of cylinder walls and stud diameters, which were matters of judgment with Birchall, would be matters of guess work with Thompson, unaided by his books.

* * * * * * *

I always had a desire to know how these book fellows could hit it so closely without having a big shop experience to guide them, and when I saw Thompson's work assuming shape and proportions, which I thought from my own practical experience could not be very far out, I concluded to ask the young fellow for information. Thompson was very accommodating, and showed me his formulas and tables and half a dozen books on the steam engine, and others on machine design: he talked of tensile strength and factors of safety just like a professor, and tried to make me understand in an hour what had taken him four years to learn. I begged him to go it easy, and said, if he would explain one thing at a time, I would like to know just how thick to make the metal in a steam cylinder. "Well," said Thompson, "that depends upon a good many things, and would be pretty hard to determine exactly; of course, the diameter of cylinder and the pressure of the steam are the principal elements in the case, but we have to consider besides these the strength of the iron, the amount to allow for reboring, a sufficient thickness to resist twisting or springing while being constructed, and also to resist warping, shocks, or other action when in service. A cylinder could readily be designed thick enough to resist the working pressure, which would actually be too thin to bore out. In order to obtain a suitable thickness, then, we cannot consider the strength of pipes or tubes to resist pressure, but must refer to successful engine practice.

A rule which will give good results as compared with first-class engines for cylinders under 20 inches diameter, when working from 70 to 120 pounds pressure per square inch, running at a piston speed of from 400 to 900 feet per minute, and which will allow for reboring, is:

Rule 1.—Multiply the inside diameter of cylinder in inches by the greatest pressure of steam on the piston in pounds per square inch and divide by three thousand; to this add half an inch; the sum will be the required thickness.

Instead of writing out all these words it will be more convenient and will save a good deal of time if we represent them by letters and symbols; thus if we let:

D = inside diameter of cylinder in inches;

P = greatest steam pressure in pounds per square inch;

t = thickness of cylinder walls in inches;

then the above rule (1) will become:

$$t = \frac{D \times P}{3{,}000} + \tfrac{1}{2}'' \qquad \text{[Formula (1)]}.$$

In locomotive practice, where the pressure is much greater, and varies from 140 to 160 pounds per square inch, it will be sufficient to add ¼ inch instead of ½ inch, as given in the rule.

To illustrate the rule, let us find the thickness for a 14-inch cylinder. We must first assume the steam pressure, which we will take at 90 pounds per square inch, therefore D = 14, and P = 90; formula (1) will then become:

$$t = \frac{14 \times 90}{3{,}000} + \tfrac{1}{2} = \frac{1{,}260}{3{,}000} + .5 = .92;$$

the nearest sixteenth to this value is $\frac{15}{16}$, therefore we choose $\frac{15}{16}$ inch for the desired thickness.

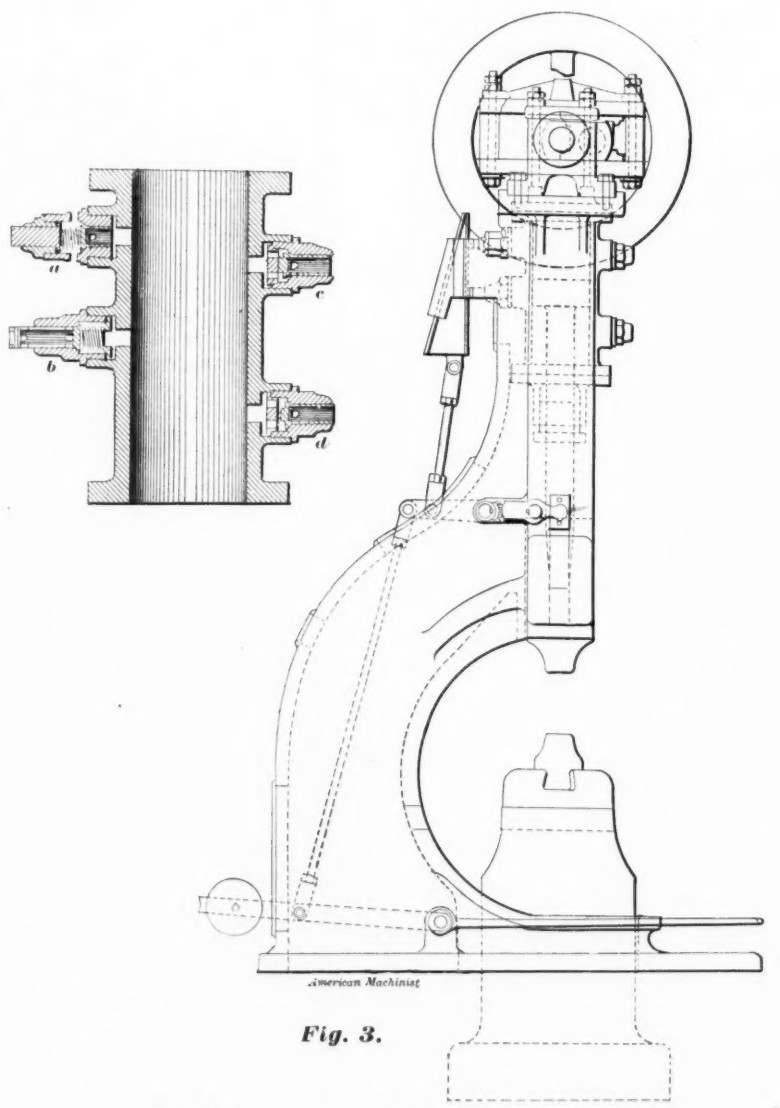


Fig. 3.

THE HACKNEY POWER HAMMER.—SEE PAGE 1.

Now," continued Thompson, "I find here in my note-book dimensions of several engines of different sizes built by reliable firms, so when I use my formula, and I find the result corroborated by a similar case from good practice, I feel very well satisfied that the thickness is all right.

TABLE OF ACTUAL THICKNESSES OF STEAM CYLINDERS.

Dia. of Cylinder.	Make of Engine.	Actual Thickness.
9	Bail....	7/8
9½	Westinghouse.....	3/4
10	Cummer..	7/8
11½	Porter-Allen.....	3/4
12	Southwark...	3/4
12½	Colt's Armory Engine	7/8
13	Buckeye	15/16
14	Lane & Bodley.....	15/16
18	Buckeye	1 1/16
18	Locomotive.	1¼
19	Locomotive.....	1¼
20	Locomotive..... ...	1¼

Thus in the table we find a 14-inch cylinder made by Lane & Bodley, the thickness of which is $\frac{15}{16}$ inch—the same value that we have just found.

Here the calculated thickness and the one taken from practice agree exactly; but from the examples shown in the table we see that the thickness might vary as much as an eighth of an inch, and still conform to good practice, as shown in the case of the 9 inch Ball engine, and the 11½-inch Porter-Allen. I don't take the value direct from the table, because the designer of the cylinder given in table may, for certain reasons unknown to me, have decreased or increased the thickness in a particular case, so I use a general rule, and knowing the steam pressure, find the thickness for any desired diameter. If this thickness should not come anywhere near the value taken from practice, I feel certain there is something wrong, and generally find there is a mistake in my figures."

Well, Mr. Editor, I have come to the conclusion that one can learn a good deal about machinery without working for fifteen years in the shop, and I thought while Thompson was talking with me, and explaining the use of his formulas, how much more valuable a man would be if he knew all this book-work, and had a good shop experience besides.

Yours truly,

CHIP.

Sketches of an Apprenticeship.

BY W. S. ROGERS.

A letter from my friend Stelzle brings up a little incident that happened some years ago that will make the term "expert" plain, I trust. A young man who had served his time in my town came looking for work in another city to which I had moved. Being particularly interested in him, and knowing him to be a good workman, I got him into a near by shop. The foreman gave him the 36 inch lathe and the 40-inch planer to run, double, and also gave him a piece to turn up in the 22-inch lathe on the other side of the shop. The boy ran the three machines, doing the work in two hours less time than his predecessor, and doing it better, so the foreman said. At the end of a week he came to my house and said he had been discharged for running about the shop. Knowing that seeing the inside of several shops would increase his knowledge and widen his views of doing work, I gave him a note of introduction to a well-known tool builder. He was put at work at once on a lathe, turning cone pulleys. At the end of the week the proprietor handed him his week's wages in the usual envelope. The youngster opened it expecting to find twelve or fourteen dollars, as any young jour. would be entitled to, but instead he only found eight dollars. Promptly going to the office he asked for an explanation, and remarked that he could get more than two dollars a day where he came from. The boss explained thus:

"Young man, do you see that man forty years old or so on the lathe across from yours? Well, he has turned and bored more pulleys than you have this week, and he is twice as old as you, and that is all I pay him. Could I justly give you, a new comer, more than I give him?"

The young man thoughtfully walked out to the old man on the other lathe, and this is about the style of their conversation: "My friend, you turn out lots of work." "Yaas?" "More than I did." "So?" "Where did you learn your trade?" "In dis shop." "How long did you serve?" "Sex monts." "How long have you worked here?" "Sex monts." "How long have you been on this lathe?" "Sex monts."

The young man took off his overalls and jumper, and hunted me up to explain to him two things: First. Why I advised him to serve his full time as an apprentice for three and one-half years, at three dollars a week, in order to earn eight as a jour. Second. Why I sent him to that shop. I think I made him see the "special" side of the case as it was, and what "expert" meant, for he has been foreman since then in other shops, and to-day is manager of a plant, and is earning profits.

The young man was a skillful mechanic; the old man an expert lathe hand. "Expert," according to Webster, means "skillful."

Now, for argument's sake, we will admit that "a boy must put in more than six months on a machine to become skillful." Let us give the boy a good chance, and call it ten months. There is the lathe, planer, milling machine, gear cutter, drill press, slotter, boring mill, vise work, and a knowledge of tool dressing, and making each and all as simple and easy or intricate or incomprehensible as you choose; they are all important to make the finished workman. Multiplied by 10 these equal 90 months, or 7½ years, and only 5 per cent. able to run a planer skillfully out of 500 men with five years' service, according to Mr. Stelzle. I am inclined to believe there is a mistake somewhere. The cubs must be awful "slow" boys, the tools must be terribly complicated, or it is to the firm's advantage that their cubs should not become expert, and thus become actually specialists.

There has come into our shop this week, to learn to be a *mechanic*, a bright, wide-awake boy. And I can guarantee that in side of five months after he gets hold of the shop planer he will do as skillful work as can be done by any one, and I know of plenty more of the same stamp.

Years of experience in one line don't always make the "expert"; more generally it creates a rut. I have rode on locomotives with engineers of thirty years' experience who were not half so expert or skillful as another with only six months' practice. I know men with fifteen years' experience on the planer and on the lathe who are still trying to "*push*" iron off, while the student youngster, with probably only six months' experience, is trying to see how much he can *cut* off and work to a fine line, and I find the only thing worrying these same youngsters is the fact that the belts and gears are not larger, and the housings stronger. A young friend of mine only got in two weeks on the planer during his cub life, but some of his best die sinking he did on the planer afterward as a jour. Is he a planer hand now? Oh, no. He served his apprenticeship not to be simply a craftsman, but to excel as a master. He is in the drawing-room now. Jack was a thinking cub, a cool, clear-headed jour., and he will make a genuine mechanical engineer.

There is nothing complicated or wonderful about the tools in the machine shop. The complications all lie in the boy and the man. Without wise instruction as boys, and constant study and effort as men, we become specialists, or rather machine tenders, not machinists or mechanics.

The man that *builds* any piece of mechanism can run it, but the chap turning cone pulleys for lathes is not a lathe builder any more than the man who planes locomotive side rods is an engine builder. They are both specialists or machine tenders.

A Mechanic Made Use of—A Point.

BY JARNO.

Gascon tells this story as a parable, alleging that a principle or fact can thus be illustrated quite as well as by the narration of actual occurrences and the disclosure of real names. Some persons think that, by writing anything for publication, one places one's self under special obligations to all of one's friends; every fact must be divulged. To appease such persons, one's only hope is to write in parables, and thus partially avoid the answering of inconvenient questions. Still, this story seems so much like a real occurrence that I believe some of the details are facts, and I give it in my own words. This time Gascon appears a little over-critical.

I have an acquaintance, Wilbrow, who is a mechanic in a general way, having, at one time in his life, learned, along with other things, something of the machinist trade, by serving an apprenticeship. So far as I learn, he has not devoted any great number of years to working at his trade, but has been an inspector, or, as some would say, a fault-finder, concerning the work of other mechanics. In this he has been successful, and on the whole his life has perhaps been of as much benefit to the world at large as the average. He has thus developed a habit of careful observation, which is oftentimes as important as mechanical skill. It is a curious fact that one who finds something that is a real fault is not a fault-finder.

Wilbrow recently went into the country to visit an uncle who is owner of a cotton factory. In the factory is a pump that failed to work, just as Wilbrow came. Now, this pump is to draw water from an artesian well, and force it into the boilers, which, in order to keep the factory running, as well as for the safety of the operatives, should be constantly supplied with water; so that, when the pump gave out, the operatives had to quit, and losses were piling up. Previous to this, the pump had given out three times. After the third time, a workman had come from the pump factory, a hundred miles away, had spent fifteen hours in repairing, and had returned under the supposition that the pump was all right. Scarcely was he fifteen miles away when it gave out for the fourth time, and the owner, in consequence, was much distressed.

Supposing that relief could be obtained only from the pump factory, he wanted Wilbrow to go at once to the telegraph office. Having but little faith that relief could be thus obtained, Wilbrow suggested that they go first to the pump. The owner smiled incredulity, but finally gave reluctant consent. They did go to the pump, and Wilbrow looked at it from an inspector's point of view, which is, in part, to consider the result of two or more things in combination after each appears right separately.

As in Fig. 1, the check valves are guided by a stem *A*, sliding in the cap *M*, and by the flukes *B*, *B*, in the hole through the valve seat. Now, when the cap was off, the valve appeared to be free enough in its guides. But when the cap was on, and the valve took just the wrong position, it was caught up, because the hole in the cap tapered smaller at the inner end, or because it was not in line with the hole in the seat, or because the end of the stem *A* was sharp cornered, or because the stem was not true with the flukes. All these obstacles were removed by rounding off the corner of the stem, and by turning off a chip from the flukes. The owner's son took the place of the engine, and had his first experience at pulling belt.

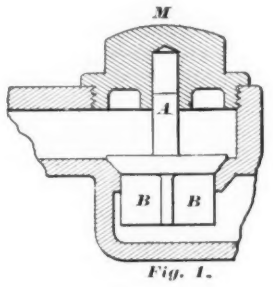


Fig. 1.

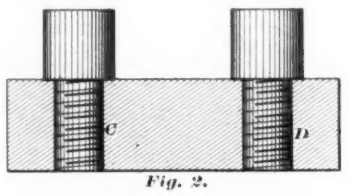


Fig. 2.

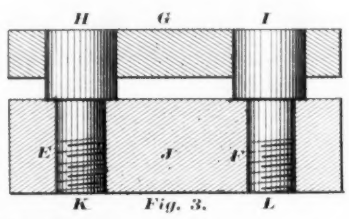


Fig. 3.

A MECHANIC MADE USE OF.

Wilbrow now held a high place in the owner's opinion, and before his visit was ended he went still higher, for the following reason: The factory was brick, and new. Why it should shake a great deal more than the old wooden one was a fact that no one had explained, and was the cause of great alarm to the operatives. The cause of this serious shaking was one with which the readers of the AMERICAN MACHINIST are familiar, it being simply that the time of the vibrations of the looms was either equal to, or some multiple of the time in which the building vibrated. Wilbrow suggested that, if the textiles would stand, the speed of the looms be increased, and, if not, that it be lessened. The speed was increased, and the trouble at once ceased. The factory does not shake now, and its product has been increased.

The successful mechanic is also one that can call out, from shadowy nooks in memory, the things once learned, now needed. There are points that the young mechanic should learn so thoroughly that he will not miss one, when needed, any sooner than he would miss centering a shaft when he has one to turn.

Figs. 2 and 3 will help to illustrate a point that should be remembered. It is related to one of the causes of the pump failure. Suppose that two studs, *H* and *I*, Fig. 3, are to be of the same diameter as two holes in the piece *G*, and are to be rigidly fastened in *J*. Now, to make sure of accurately positioning the studs, we must do something more than simply thread them in holes like *C*, *D*, Fig. 2. Even though the holes are accurately spaced, and most carefully threaded in a lathe, there is no certainty that the positions taken by the studs will be correct. A good way of holding them is to have a portion of the hole plain, as at *E*, *F*, Fig. 3, and in this portion have the stud fit tight. Below the plain part of the hole the stud can be threaded, as at *K*, *L*. The office of the thread now is only to draw the stud in and hold it endways, while the plain part holds it sideways. If there is room, a still better way than Fig. 3 is to fit a stud in a plain hole clear through *J*, and put a nut on the under side. Though not likely to do so, yet a stud might take the right position, if simply threaded. As to what can be expected of this Fig. 2 method, I should not depend upon it for one inch diameter of thread, and smaller, when the parts are threaded in a lathe, unless I could allow a variation of one one-thousandth of an inch, and, when the holes are tapped, two one-thousandths.

Having established somewhat a reputation for being a great mechanic, as well as a man desirable to have in the community, Wilbrow was reluctant to visit his uncle again, for fear that he might fail to do the next thing needed, and thereby lose some of his reputation. He had heard that a long time ago, in a far country, a man did two good things, and gained thereby, but, by afterward failing to do a third good thing, he lost more than he had gained. However, Wilbrow did visit again, after a long time, and has thus far succeeded in keeping his reputation afloat.

A Simple Method of Calculating the Mean Effective Pressure of Steam in an Engine Cylinder.

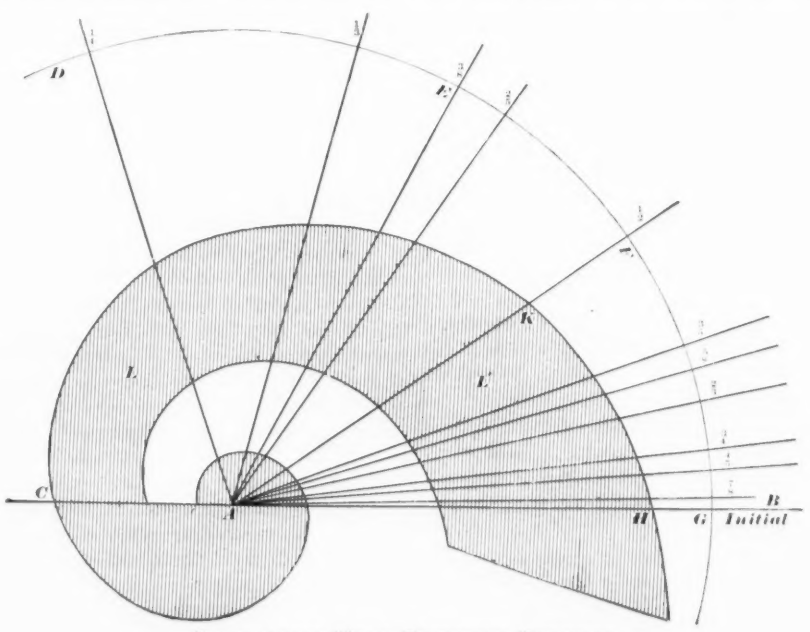
BY WM. COX.

All those instruments so well known to the engineer, and which are such valuable aids in his work, such as the planimeter, the pantograph, the proportional dividers, the slide rule, etc., owe their usefulness to the mathematical principles upon which they are constructed.

In the accompanying figure we show a novel, simple and efficient instrument, based on similar principles, for calculating the mean effective pressure of the steam in an engine cylinder, with any cut-off. It consists of a sheet of cardboard, on which is traced the arc *D E F G*, with center *A* and radius *A G* of about six inches. This arc is divided into several parts, which, according to the general principle of numbers in arithmetical progression, answer to the ratio of expansion of steam, or the total length of stroke divided by the distance traveled by the piston before the steam is cut off, as ⅓ths, 4-5ths, ¼ths, etc. Radii are drawn from these various points to the center *A* of the arc. To complete the instrument, take a logarithmic curve *L L'* in cardboard or other material, representing numbers in geometric progression, as shown by the shaded portion of the figure, and pass a fine needle point through its center, and through that of the arc *D E F G*, so that the curve may revolve freely round the axis *A*. Any length *A H*, measured then on the base line *A B*, by a convenient scale of equal parts, will stand for the initial pressure of the steam in the cylinder, and any other length, as *A K*, measured on one of the various radii by the same scale, will give the mean effective pressure for the cut-off represented by the given radius.

If by a scale of millimeters, for instance, the logarithmic curve be so turned round that *A H* may measure 120 millimeters, and taking this to represent the initial pressure of the steam in the cylinder, we then hold the curve in the same position and measure *A K*, we shall obtain 101½ millimeters, which figure is the average pressure of the steam in pounds per square inch for the whole stroke, with the steam cut off at half of the stroke. Likewise for any of the other radii, we obtain the average pressure for the cut-off represented by each given radius, by measuring the length from the center *A* to the edge of the curve where it is cut by the given radius, taking care always that the curve be held fixedly in the position to which it is set in accordance with the initial pressure of the steam.

The various remarkable properties of the logarithmic curve, for which many other uses may be found, require that it be constructed with great accuracy. Correct curves made of black rubber or celluloid may be had of any dealer in drawing materials, also sheets of bristol board upon which the arc



CALCULATING MEAN EFFECTIVE PRESSURE.

D E F G is traced with the points of cut off, also scales of millimeters which are very suitable for these calculations for initial pressures up to 145 pounds per square inch, or scales of 40 parts to the inch, which serve for initial pressures up to 220 pounds per square inch.

Shop Notes.

(Editorial Correspondence.)

Visiting the Niles Works, at Hamilton, I found them just getting an extensive addition to the works completed, men from the Morgan Engineering Works having just arrived to put up the traveling cranes. There are two of these of twenty tons capacity each. The new building is alongside of the original machine shop, adjoining it, and over the canal known locally as the "hydraulic" from which the works, when new, derived its motive power. The new building is 400 feet long and 100 wide, and, when entirely completed, the wall between this and the old shop will be taken down, making a machine shop 400 feet long and 225 feet wide. Besides this there is a new shop across the street, which was completed last year, and will be devoted especially to building lathes of certain sizes. Along one side of the new addition will run a gallery upon which will be placed the lighter machine tools used in the making of the smaller details, which will be made by jigs and other appliances on the interchangeable plan, so that when taken to the floor below they can be put onto any machine. On this gallery, too, will be located the tool-room, which it is the intention to supply with a full line of the most modern tool-making tools and appliances. The intention is to entirely separate the work of making shop tools from the regular work, so that neither will in any way interfere with the other. The tools when completed will not be kept here to be checked out, but will be put in a room provided for that purpose, so that the time spent in receiving, giving out and caring for tools will be kept entirely distinct from the cost of their production. The drafting-room, which is over the offices, will be connected with this tool-making room by a balcony running along the front end of the shop.

There will probably not be as imperative need of the added capacity afforded by this addition as it was thought would be the case when it was planned and begun; for at the Niles Works I found, as at most other tool-building establishments, that the demand for tools had slacked off somewhat, and that there was a prospect of catching up with orders, something which they have not been able to do for some years past, though working night and day for a good portion of the time. Nevertheless, I could detect no indication of a feeling of regret that such extensive building operations had been begun, but on the contrary, they seem confident of being able to put the increased capacity and facilities to good use. It has not, in fact, been expected that the rush which has prevailed for the past few years would always continue, and it is probably not desirable that it should do so.

Among the tools in process of building, I noticed a planer to plane 10 feet square, and one is to be built to plane 12 feet square. These are to be used in their own shops. There was also a boring and turning mill for the Walker Mfg. Co., of Cleveland, which is to swing up to 24 feet, and will weigh about 150,000 pounds. This machine has the housings arranged to be run back for swinging the larger work, its nominal capacity when the housings are run forward being 16 feet. There is an arm which goes onto the cross-rail, which, when the housings are run back, extends out to the center of the table, and carries at its extremity a boring bar which is fed automatically. The tool bars on this machine have a vertical or angular traverse of 6 feet, and the angular adjustment of the heads is effected by means of worm gearing, the heads being so heavy as to make it advisable to thus have them always under control when the binding bolts are loosened. Some very heavy tools are in course of construction for the Cramps. During last year 53 boring mills were built here, many of them very large ones, and the output of driving wheel lathes averaged about two per month.

PUMPS AND PUMPING ENGINES.

At the shops of the Gordon Steam Pump Company, which is close by, and closely identified with the Niles Works, there seems to be no indication of a slacking off of business, and the shops are still running nights to get out the work. A new building has just been completed, which is of substantial frame construction one story high, with light from above, and will be provided with a traveling crane. Many pumping plants for water-works are built here, and the floor of the new building will be fitted up with special facilities for setting up and testing under steam the largest pumping engines.

THE LONG & ALLSTATTER CO.

The shops of this company were found to be fully occupied with work, most of which was punching and shearing machinery of the heaviest character, a good deal of it specially designed for some certain job. The tendency seems to be decidedly towards the employment of gangs of punches, wherever the nature of the work will admit of it, and this, of course, necessitates the building of very heavy and powerful machinery to drive them through. At the time of my visit there were machines in course of construction for punching metal for coal screens, and there were others made especially for I beams, where there was a gap through which the beam was passed, each flange resting on dies in such a way that two or more holes could be punched through them simultaneously. There was one machine which was made to punch six 1-inch holes through 1-inch steel. One of the uses to which these machines are being put, which is rather out of the usual line, is for welding tires. Fitted with suitable dies for this, a machine, otherwise very much, if not exactly like an ordinary punch or shear, welds a wagon tire one inch thick and four inches wide in three seconds.

The character of the work done does not give much opportunity for the employment of many special devices outside of those which we expect to find in most machine shops. So far as possible the work is done by jigs and templates, but the main dependence must be upon the ordinary machine shop methods and tools.

I noticed, however, what seemed to be a very good way of arranging a shaper to do work much larger than it was intended for, or would otherwise be capable of doing. A pit was dug in front of the machine, in which a large piece of work could be placed. This, so far, is nothing new; but this pit was walled up and supplied with a platen to which the work could be secured, and this platen could be raised and lowered by power from the countershaft, there being a large vertical screw at each corner of the platen. The screws were made to move together by means of sprocket wheels connected by a chain, one of the screws being driven directly from the countershaft by means of gears and a clutch. There are uprights also to which the platen can be firmly clamped after it is adjusted to the desired height. Thus this pit is made much better than the mere hole in the ground, which we sometimes find in front of shapers and drill presses.

CINCINNATI—THE G. A. GRAY CO.

The shops of the G. A. Gray Co., where about 90 men are employed, are devoted exclusively to the production of planers, and no one who goes through them, noting their methods of doing work, can doubt that the efficiency of the men and tools is very high, this being due in part at least to the fact that the efforts of every man about the place, from Mr. Gray himself down to the laborers, are concentrated on this one thing. The efficiency would be still higher with better arranged and more modern shop buildings, those occupied at present being somewhat outgrown, as well as too much cut up to be entirely satisfactory. Better shops will probably soon be secured by the erection of new buildings in or near Cincinnati.

All the small parts of planers built here are made in lots by special tools, and fitted up complete without reference to the particular machine which they are afterwards put into, and this is extended even to complete heads, or cross rails with or without the heads. This is accomplished by the liberal use of the surface plate in scraping, it being recognized that, if two surfaces each fit a true surface plate, they will fit each other.

In planing angular cuts on the planers, such as those for the Vs of the platen for instance, the graduations on the head of the planer are not depended upon for the accuracy of the angle, but there are standard templates which resemble the draftsman's triangles. These are placed on the platen, and the head is then set so that the tool, which is placed in position, will move in a line parallel to the angular surface thus presented, the setting being tested by means of tissue paper drawn through between the tool and the template. Thus, whether the angle is precisely any given degree or not, it is a fixed thing which can be duplicated at any time. Extraordinary pains are taken with the planers used in the shop, to the end of having them produce surfaces which shall be as true as it is possible to make them in this way. They are for the most part (at least the heavier ones) put down on permanent foundations, and are frequently tested for their truth, the object of this being to reduce the scraping needed to produce fits to the smallest possible amount.

The first frog planer made at this shop was recognized in the beginning as something of an experiment in some respects, and it was thought at the time it was built that some changes would probably be made after it was started running.

One of the first things done was to replace the platen with one somewhat longer, which was afterwards replaced by a third one, still longer, and though the slides had been scraped to a bearing, the two new tables fitted perfectly. This was accomplished by first making two gauges of cast-iron, one of which was the exact duplicate of the Vs in the bed, while the other was the exact duplicate of those on the platen. They were not, of course, made the full length of the bed and platen, but were sufficiently long to answer their purpose. These were accurately fitted to each other by scraping, and then the bed of the planer was fitted to one, while the platen was fitted to the other, the result being, of course, that the bed and platen fit each other. The platens subsequently made were fitted by scraping to the same female gauge, and so, of course, fit the original bed.

One of the impelling causes to the adoption of this plan was the lack of room and facilities for readily handling the platen in the manner that would have been necessary in scraping it directly to the bed in the ordinary manner, and thus this was a case where the seeming lack of sufficient room led to the adoption of a plan which was found upon trial to have peculiar merits of its own, aside from those which were mainly in view at the time of its adoption.

For planing the Vs at a precisely uniform distance one from the other, standard length bars are used, which are placed on top of the cross rail, and the head run up against them for the succeeding cuts, as shown in our issue of Sept. 19, 1889, and which is the best method I have yet seen for securing accuracy in such work.

For boring the holes through the bed, which are afterwards bushed to form the bearings for the various gear shafts, they use a fixture, which consists essentially of a rectangular frame having Vs which fit into those of the bed, which have been previously planed. The frame extends out over the sides of the bed sufficiently to admit of arms being attached to it, which project downwards at the sides, and carry bushings through which the boring bars work, these bars being driven by a drill press.

Thus, by simple means, absolute uniformity as regards center distance from each other and from the rack is secured.

GEAR AND RACK CUTTING.

A plant of automatic machinery is used for making the gears, which includes a gear cutter built especially for this firm by Gould & Eberhardt—the largest machine of the kind yet built by them. It is capable of, and is used in cutting the large gear which engages the rack of the platen, while the rack itself is cut on a planer. In this connection, Mr. Gray gives some figures which are interesting, and have a bearing on the question discussed some time ago in these columns as to the respective merits of milling and planing. The best which the machine has yet been able to do in cutting a certain size of these gears is 3.6 lineal feet per hour, while the planer cuts the rack in which the gear works at the rate of 10.4 feet per hour. This is certainly a good showing for the planer, but it might not fare so well in comparison with the automatic rack cutter built by Gould & Eberhardt, which we illustrated in our issue of Nov. 13, 1890, which uses as many as twelve cutters in a gang, finishing six teeth, and roughing six more at each passage through the work, something which, of course, is not possible in the case of gear wheels.

A LARGE TURRET HEAD MACHINE.

The plant of machinery for making gears is in a room by itself, and here I noticed a turret head machine, which is a little out of the usual line in such machinery. It is used in boring and facing gears, and will swing in the chuck up to 36 inches diameter. The turret, which is correspondingly large and heavy, has an automatic longitudinal feed as usual, and, in addition to this, has a cross-feed of 12 inches, so that, in addition to using the ordinary boring tools such as are usually found in these machines, others which are adjustable to the cut, the same as a lathe tool, can be used, and hubs of gears faced. At the time I noticed it, the job being done was a cast-steel pinion for the frog planer, the hole through this being 5½ inches diameter, and 14 inches deep.

THE DRAFTING-ROOM.

In the drafting-room, which is in charge of Mr. Ernst Richter, I noted some things which are different from those found in most drafting-rooms, the most notable of these being perhaps their practice of making all drawings upon sheets of one size, made of bond paper, cross-ruled with light green lines ⅛ inch apart, every eighth line (indicating inches) being made enough heavier to be easily distinguished from the others The ruled portion of these sheets are 14 x10 inches, with a very narrow blank margin, except at the top, where there is printed the name of the firm, with blank spaces to be filled with the date, symbol, etc. Blue prints are made directly from these sheets, and they are made in the best and neatest blue print frame that I have yet seen. I will not describe it, however, for the reason that I have Mr. Gray's promise that he will send a drawing of it for publication.

THE MODERN PLANER.

As an example of the power of the modern planer, and what is expected of it, a steel chip which was shown me while here is interesting. It was cut from a steel rail in the shops of the Indianapolis Frog and Switch Works, by a "Gray" frog planer having two heads. It was 2 inches wide, ⅛ inch thick at one edge, and ⅝ inch at the other. The tool which cut it off was evidently in anything but good condition, as the under surface of the chip plainly showed, and the entire chip was heated to a straw color in cutting, with here and there a blue spot at the edges where it was thin.

A feature recently introduced by this company in planer construction is the extension of the reversing rock shaft through the bull wheel shaft to the back side of the planer, and here they put on two reversing dogs at the back side of the bed the same as in front. This makes the planer very convenient to handle at the back, when it be-

comes necessary for the workmen to stand there, as, of course, is often the case with large work.

LODGE & DAVIS MACHINE TOOL CO.

At these shops there were, at the time of my visit, about 400 men employed, the shops having been recently much enlarged by the purchase of a building adjoining the original shop, which was occupied by a firm which has moved away from the city.

CLASSIFICATION AND DIVISION OF WORK.

The ruling principle of this shop seems to be the minute division of labor, both with regard to the men and the machine tools, one man and one tool being, so far as possible, kept on one particular job, and provided with special facilities for doing it. Lathe spindles, for instance, are all roughed out in certain lathes devoted to that purpose, while they are finished in others which do nothing else, and are fitted for turning them on dead centers. Cone pulleys for heads of lathes are turned in a lathe devoted to that job, and which is supplied with an arbor which is suitably supported on the centers, but does not revolve, the pulley being revolved on the arbor upon its own bearing, the same as it afterwards does when in place. This, of course, not only insures truth without depending upon the ever-wearing arbor centers, but also insures uniformity in the size of hole, since this uniformity becomes necessary to the system of manufacture. The shops are also thoroughly subdivided as regards the different kinds of work, drill presses being made in one part, while lathes are made in another, and so with planers, etc.

SPECIAL FIXTURES.

There are very many special appliances to be seen here which are interesting, but which I cannot describe in detail, for the reason that such a description would not only be somewhat tedious, but unsatisfactory as well, without sketches, but as typical examples of these I noticed, among other things, that they have a fixture for boring the holes through the bed of their planer to receive the gear shaft bearings, which fits to the planed Vs, the same as the one seen at Gray's, but is arranged to bore all the holes simultaneously, the bars being driven by a special machine, which allows the bed to lie in its natural position. Bosses are cast on the inside of the bed, through which these holes are bored, there being just room between the ends of opposite bosses to admit the gears, so that the shafts are supported close to them by what is really part of the solid bed. This makes the boring job quite an extensive one, and, of course, much time is saved by boring all the holes together. The use of this fixture involves uniformity of planing of the Vs also, though I did not notice how this uniformity was secured.

TURNING LATHE SPINDLE BOXES.

The composition boxes used for lathe spindle bearings are so made as to be finished entirely in the lathe, the body of the box being round outside. They have arranged to turn these all over on an arbor without soldering the two parts together, as is usually done. A hole is drilled through each half of the box in the center, corresponding to the location of the oil hole. The boxes which have been previously bored and reamed are secured to an arbor which has a corresponding hole passing through it, and a bolt passed through the two halves of the box and the arbor secures the former in place, while the flanges at each end of the box are turned. Each end of this arbor is threaded, and there are nuts fitted with washers, or rather collars, which are cupped out inside, so that, when they are brought up against the ends of the boxes, and tightened, they press the two halves firmly to the arbor and hold them in position. The bolt which formerly held them is then removed, and the body of the box turned to fit its seat in the head, and the inside of the flanges faced true at the same time.

RACK CUTTING.

There are nine gear-cutting machines, part of them automatic, and there is one machine which has been arranged to cut racks, that is something of a novelty. In its general features it resembles a planer, but in place of the cross-rail there are supports for the cutter arbor which extends across the machine, and is filled with cutters which are made of a thickness over all just equal to the pitch of the rack to be cut. At either end there are cutters which cut off the ends of the blanks to uniform length at the same time. At the time the machine was working on 8-pitch racks, of steel, which were placed one behind the other on the bed, and were being cut to uniform lengths of 24 inches, and all the teeth cut in them at one pass. Of such a rack it has cut 60 lineal feet in 7 hours, or a little over 8.5 feet per hour. The cutters are not removed from the arbor when racks of different pitch are to be cut, but the entire arbor with its cutters is removed, and another one substituted. Each of these arbors, with its cutters, cost about $360, but, of course, they pay well where there is enough rack cutting to justify their employment.

CROWNING PULLEYS.

Another example of the means adopted to facilitate work, and at the same time secure uniformity, was noticed in the device used for turning feed cone pulleys. The steps of these pulleys are rounded on the face instead of being turned taper each way from the center, as is usually done, and if there are four steps they are all turned at once by a device which resembles what is known as the English slide rest, made to hold four tools, or as many as there are steps on the pulley, which are set with regard to each other by means of a gauge. The upper slide of the rest, which is parallel to the arbor or center line of the work, is then moved to give the feed, and as it moves it rotates a small pinion by means of rack teeth, which are cut upon the slide. This pinion is on the upper end of a short vertical stud which passes down to the lower slide, which is at right angles to the first, and to the center line of the work. At the lower end of the stud is an eccentric working in a square block, which fits a slot in the slide, so that, as the upper slide is moved along, the lower one is first drawn out, and as the center of the face of the pulley is reached, moved inwards again just sufficiently to produce the crown. This, of course, avoids the necessity for setting centers over to give the required taper, admits of the entire face being turned at one continuous cut, and besides, gives a form for the pulley, which is, no doubt, better than the usual one.

ECCENTRIC SHAFTS.

The shafts upon which back gear quills run, and which have the eccentric pivots at each end, are provided with double sets of centers for turning them, but after the body of the shaft is turned it is put into a fixture which is supported on two standards fixed to the lathe bed, these standards affording bearings in which a long sleeve revolves, which has a hole through it, into which the shaft is put with the end projecting the proper distance, this hole being eccentric with the outside of the shaft. One projecting end is then turned true, after which the sleeve is reversed in its bearings, and the other end turned the same, so that this becomes a very simple operation, done in such a way that absolutely uniform results are obtained.

OIL STONING SCRAPERS.

In oil stoning scrapers, revolving oil stones are used, the machine in which the stones are mounted being provided with facilities for holding the scrapers while they are moved along in front of the wheel, in a straight line, so that not only are scrapers sharpened much more quickly than can be done by the old method, but straight cutting edges are insured.

A FORWARDER OF WORK.

I discovered a new shop functionary here of whom I never heard before. It is his especial duty to see that work which has been carried forward to a certain stage is then moved ahead to the place where it is to go through the next one, and he is called the forwarder of work. He is supposed to know where the work under his charge is, and all about its condition or stage of progress towards finish, and relieves the foreman entirely of this part of the work.

Liberal use is made here of the grinder in finishing work, there being a number of grinders of various styles among them, two Brown & Sharpe universals and one of Landis Brothers make. Lathe spindle bearings are ground, as are also the thrust collars, which are of hardened steel, and are ground with special reference to enabling true surfaces to be produced on the lathes by facing work held in the chuck or on the face-plate.

ELECTRIC ANNUNCIATORS.

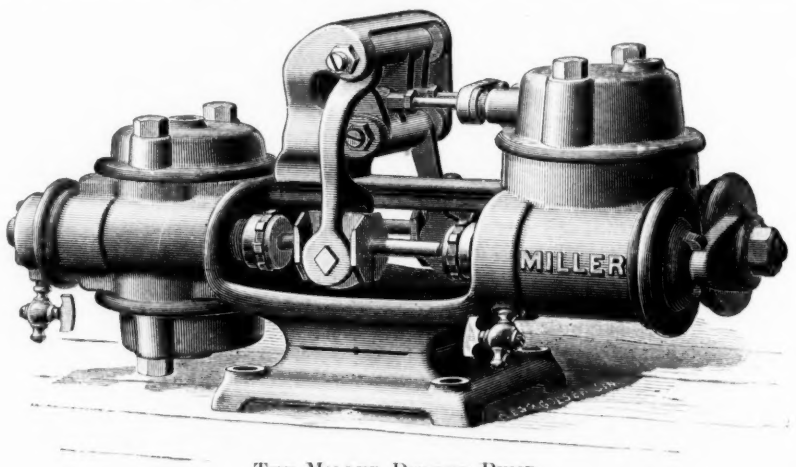
In connection with the tool-room system, I noticed that they have adopted the call-bell system that is in use in hotels, by which the locality or room from which the call comes is indicated by a number, which is uncovered at the time the bell is rung. For this purpose the shop is divided into small sections, with a few men or machines in each. An electric button is provided in each of these sections, and when any one is in need of anything from the tool-room he simply touches the nearest electric button, when a boy, who is stationed at the tool-room, comes and receives the order for the thing wanted, and brings it.

DRAWINGS REPLACED BY SAMPLES.

For all the smaller parts of machines, the man who is to work on them, when applying at the tool-room, is furnished with the gauges and tools for the job, and with them a finished piece, which is just as his work is to be in every respect; size, form and finish being just as the work is wanted. These have been found to be more satisfactory in many respects than drawings or blue prints—there is less liability of mistakes or misunderstandings—and the sample piece shows one thing which cannot be indicated by any drawing, *i. e.*, the exact character of the finish required at every point. F. J. M.

It is said to be settled that the Michigan Central Railroad Company will build a tunnel under the Detroit River between Detroit and Windsor, Canada. The tunnel will be 8,000 feet in length.

The American Association for the Advancement of Science will meet at Washington, D. C., on Aug. 19.



THE MILLER DUPLEX PUMP.

The Miller Duplex Steam Pump.

We give an illustration on this page of a duplex steam pump which is typical of a line of pumps built by the Canton Steam Pump Co., of Canton, Ohio.

The pump from which the illustration was made has 2½" steam cylinders, 1¼" water cylinders, and 2½" stroke, its weight complete being about 60 pounds.

These pumps are of the Worthington duplex type with modifications, making what is known as the "Miller Duplex."

A special object which has been kept in view in designing them is to secure simplicity of construction, and adapt them to situations where the services of a machinist would be out of the question in case of an accident. It is manufactured upon the duplicate interchangeable plan. The piston and plunger rods are of non-corrosive composition metal, and are separated at the crossheads. In this way either piston or plunger can be removed without disturbing other parts, by taking off water and steam cylinder heads by removing one bolt in each.

The plungers are also of composition metal, and consist of two piston heads fitting the water linings perfectly, between which is inserted a soft packing. The wear of this packing can easily and quickly be adjusted and taken up; by its use practically all slip or loss by friction is dispensed with, and the full capacity is thus assured.

Water cylinders are removable, and made of very hard composition metal. Water valves are furnished suitable for either hot or cold water, and by removing *two bolts* both suction and discharge valves can be removed instantly. All stuffing-boxes and glands are of composition metal, and are very accessible. The entire water end of pump which would in any way be affected by rust is made of non-corrosive composition metal. The same arrangement of levers is used as on larger pumps of the same make, which, being universal, all wear can be adjusted and taken up centrally, and the pump made quite simple and compact.

The pump is adapted to boiler feeding or for any purpose for which such pumps are usually employed.

Influence of a Receiver Jacket.

Prof. D. S. Jacobus has an interesting article in the April number of *The Stevens Indicator* on: "Influence of a Receiver Jacket on the Indicator Cards of a Compound Engine," from which we extract the following:

"The engine tested was built by the Hewes & Phillips Company, and now furnishes power for their works at Newark, N. J. It is a compound engine of the Corliss type, with both pistons attached to the same rod.

"There are no jackets on either of the cylinders, whereas the receiver is jacketed with steam at full boiler pressure.

"The dimensions are as follows:

Bore of high-pressure cylinder in inches	12
Bore of low-pressure cylinder in inches	22
Stroke in inches	36
Diameter of high pressure and low-pressure piston rods	2 3/16
Diameter of second low-pressure piston rod	3 1/16
Clearance in per cent. of net volume H. P. cyl.	3.2
Clearance in per cent. of net volume L. P. cyl.	6.1
Surface of receiver acted on by the jacket steam in square feet	30

"The object of the test was to determine the form of the indicator cards, with and without steam in the jacket of the receiver.

* * * * * * *

"From these the following facts are demonstrated:

"1. The expansion line of the low-pressure card is raised by the action of the steam in the receiver, so that the mean effective pressure during expansion is increased about one-half pound per square inch, which is approximately 7 per cent. of the whole.

"2. The pressure in the receiver is increased about 4 per cent.

"3. The steam at release in the high-pressure cylinder accounted for at cut-off in the low-pressure cylinder was 64.6 per cent. with no steam in the jackets, and 71 per cent. with steam in the jackets. As no opportunity was offered to measure the steam condensed in the jacket of the receiver the economy of the jacket cannot be deduced."

LETTERS FROM PRACTICAL MEN.

The Schiele Curve.

Editor American Machinist:

If the theory of Schiele's bearing was more generally understood there might be a greater number of machine builders willing to try it, and it would then be finally settled whether or not it is better than the plain step bearing. With this in view, I submit the following:

First it must be remembered that all materials are elastic, steel and brass noticeably so. Fig. 1 represents the flat end of a revolving vertical shaft on a support of same size and material. After it has been in use for some time, and all weight removed, it will probably assume the shape shown exaggerated in Fig. 2, because wear is greatest where the movement is greatest; but with the weight on, it will, on account of the elasticity of the material, still show a straight line of contact, as in Fig. 1. It is evident that the pressure on that bearing will not be equally distributed, but be greatest in the center, which may result in destruction of the surface, if oil is driven out by centrifugal force.

With Schiele's bearing, the pressure is and will remain equally distributed over the whole bearing surface, because it *does not change its shape by wear*.

Fig. 3 shows the curve of Schiele's bearing. The pressure on each square inch of surface will be the same as on a flat bearing of same diameter; for let the weight to be carried by a part $a\ b$ of the shaft be 100 pounds, then by resolution of forces, as in the well-known wedge problem, we find this weight to exert a pressure of 200 pounds on the slanting surface $c\ d$. But this surface is twice as large as the horizontal surface $a\ b$, and the pressure per square inch will therefore be the same on both surfaces, and this is true, or supposed to be true, for all symmetrical bearings. If we now assume the wear to be exactly in proportion to velocity, then it is evident that wear in a direction perpendicular to the bearing surface will be in proportion to the radius, and it can be shown that such wear will not change the shape of the equitangential curve, or Schiele's curve, where tangents $e\ i$, $k\ m$, etc., are of equal length.

In Fig. 3, let $e\ f$ represent wear perpendicular to the surface at a point e, then draw $f\ g$ parallel to the axis, and obtain two similar triangles $e\ g\ f$ and $e\ h\ i$, in which

$$e\ f : R :: f\ g : T.$$

But as wear is proportional to radius, we may put $e\ f = n\ R$, where n is constant, which gives $f\ g = n\ T$, a constant quantity; that is, the perpendicular $f\ g$ is of the same length for any point in the curve. Now make $e\ f$ infinitely small, and g will be a point in the curve; by dropping this point a very small distance we obtain its new position after a small amount of wear, and dropping every point in the curve the same distance will give another curve exactly like the first one. J. BEGTRUP.

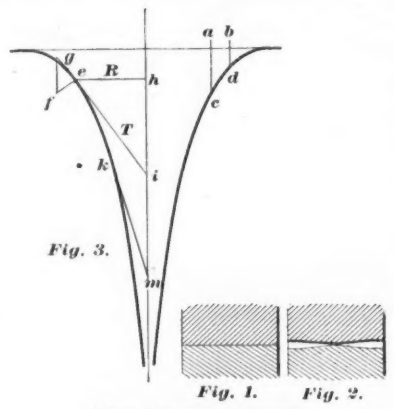


Fig. 3.

Fig. 1. Fig. 2.

THE SCHIELE CURVE.

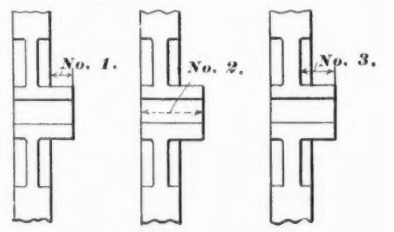
Pumps.

Editor American Machinist:

Regarding "Knowsbetter's" exception to my answer to Query No. 113, I wish we could hear from your correspondent at New Orleans before going into details. When I wrote the reply I merely supposed that he was using a centrifugal pump, and if it should turn out that he is using a piston or rotary pump this explanation would not apply.

A centrifugal pump imparts motion to a body of water exactly as a fan blower does to a body of air. The minimum power absorbed by a blower or a centrifugal pump at a given speed in its proper element is when its outlet or inlet is closed, the maximum when both are free. I have assisted when Sturtevant blowers were being tested on cupolas, and as they are usually mounted for this service so that the belts can be tightened while the blower is running, it affords the best possible evidence of this fact. The cupola being empty, with the blast gate closed, the two belts will run smoothly while quite slack; open the blast gate, and if the belts were slack enough they will begin to squeal so that you can hardly bear the noise, and several turns of the tightening screw will be needed before the belts will drive, the pressure gauge in the meantime indicating almost exactly the same pressure, except a slight fall, due to the slowing down of the speed of the driving wheel (water-power in this case), this also showing that the free outlet calls for more power.

If "Knowsbetter" will call at our Ontario Mills, he can see two sets of two six-inch centrifugal pumps, arranged tandem compound, speeded so that the gauge on each pump indicates 20 pounds pressure, while the delivery shows 40 pounds. These pumps are piped with 8″ pipe, and driven by 12″ belts on 20″ pulleys.



LENGTH OF HUB.

So long as the discharge is at the tanks the pumps run so quietly that you would say they are doing but little, although they are 80 feet below the tanks, and discharge not far from 2,500 gallons per minute. Open an 8″ tee a few feet above the pumps, and it is absolutely impossible to keep the belts on the pumps.

Why? Because they discharge nearly 4 times as much water, and the gauges indicate the same pressure. Perhaps Knowsbetter will say that the particular pumps we use are at fault, but he can rest easy on that score. We have some from every maker that we can think of. Our industry (paper making) calls for a legion of pumps—63 actually running in our two mills today—of which over 40 are centrifugal. All, excepting the fire pumps, are required to run continuously 24 hours a day, and several are in the repair shop most of the time. If he should happen here when we are testing the pump fans for balance, he could satisfy himself that the speed of the fan determines the power it can absorb, and the shape of the case has nothing to do with it.

In testing, the fan is placed in a wooden penstock instead of its case; water is let in until it is covered about 8 feet; this should give a pressure of nearly 4 pounds. As the fan cannot get up any higher pressure in this box, we should be able to attain any reasonable speed, but the resistance to speed is greater than it is when pumping against 20 pounds pressure, and a belt that will drive the pump in regular service will not begin to drive it in the testing-box.

A. H. LEFEBVRE.

Figuring Change Gears—Length of Hub.

Editor American Machinist:

Mr. Robertson's method for change gears is very simple, and he solves that particular case very quickly, but he does not tell us why or how he selected the numbers 50 and 5 for his divisors. What have they got to do with 8,659 and 4,700? Why not use 37 and 7, or any others?

If the reader will not ask too many troublesome questions, I can give a still simpler rule—divide both the given numbers by 247.4, and you have 35 and 19 at once. This rule, like Mr. Robertson's, will work very well backwards, to determine the result when you know what it is, but when going the other way it is lame.

The method by continued fractions not only solves the problem very easily, but carries with it the proof that the solution is the best one possible.

Will Mr. Robertson kindly apply his method to the ugly fraction 77,431 ÷ 11,842, and not only tell us what divisors to use, but how to determine them without first knowing, by continued fractions, that 85 ÷ 13 is the desired reduction.

If there is one thing in a written description of a gear wheel that is more troublesome than any other, it is the expression "length of hub."

What is the length of the hub? There are three solutions of the problem, all correct. Number one is the most common, number two comes next, and number three is not at all uncommon.

Number one is the most correct, as the part of the center inside the rim is really the "boss"; number two would be much better expressed by "length of hole"; while number three is very plausible. The fact is that the expression "length of hub" means nothing, unless there is a sketch with it, and then no expression at all is required. In my practice I adopt number one, because it can very easily be changed to number two or number three by cutting off a little.

GEO. B. GRANT.

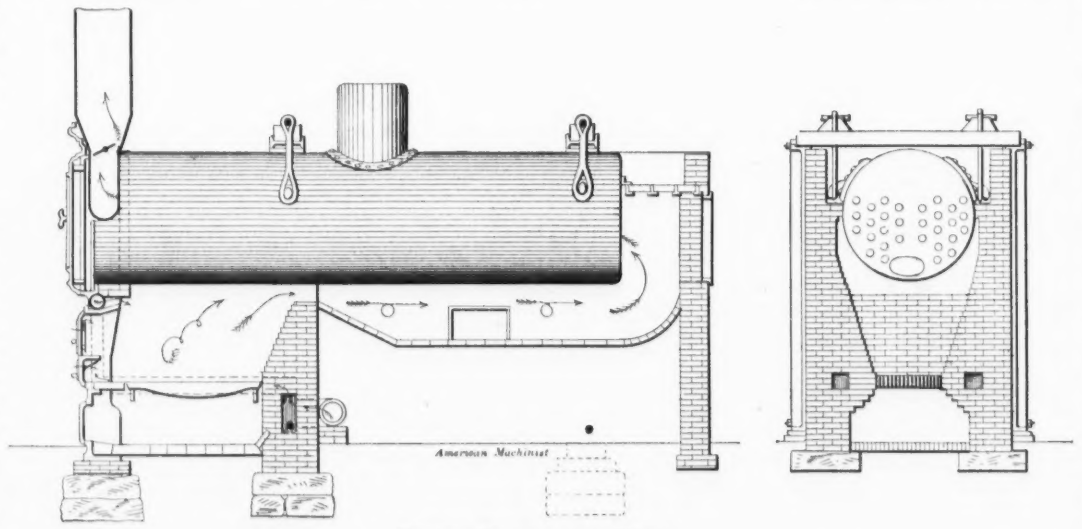
This statement is bold and positive, and so diametrically different from my teaching and experience, that I feel called upon to state as positively that the author never tried any experiment to prove his ground, and I incline to the belief that he never stopped to consider the subject in a practical way, but figured out the problem in his office on the basis that "one pound of bituminous coal requires 150+ cubic feet of atmospheric air to give good combustion," and that an increased margin of from 25 per cent. to 40 per cent. would solve all the rest of the problem, where wood was used instead of coal.

I am not inclined to go into the many questions affecting proper wood-burning furnaces, but will state my conclusion, which is that a wood-burning furnace should be only about one-half the grate area of a coal-burning furnace, but the depth of furnace should be fully double.

Just stop to think a moment. In lighting a match, do we hold it horizontally to make it burn, or do we hold it vertically with the ignition at the lower extremity? Again, in building a bonfire, do we spread the combustible all over the ground, or do we heap it up, making it as high as possible, and still keep it together?

I enclose a rough tracing of an old design of a boiler setting having a furnace for wood. The shape of the furnace is clearly shown, and requires no explanation. I will say, however, that the furnace doors are divided into an upper and lower section, the upper section being about twice the depth of the lower section, and is the door to be opened to fire the furnace. The lower section is hung so as to swing open without touching the upper one, and has a horizontal flange at its upper edge, as shown, to facilitate firing above it. For shaving or bagasse, I prefer to have a deeper chamber back of bridge wall than here shown, but, in any case, afford more than ample means to clear out this chamber at all times.

This particular hanging of the boiler in brickwork is peculiar to myself, and affords means for the shell to go and come without disturbing and cracking the walls, but the peculiar furnace is the important thing, and I feel justified in saying that it fills the bill for a wood burner when no other shape or proportions will. OROSCO C. WOOLSON.



BOILER SETTING FOR WOOD.

Boiler Setting for Wood.

Editor American Machinist:

I recently read the following in an old issue of a monthly journal. It was under the head "Points for Engineers":

"When wood is to be the fuel employed under a boiler, the grate area should be from twenty-five to forty per centum larger than if coal were to be the fuel used."

A Question in Magnetism.

Editor American Machinist:

I have a question in magnetism that I would like to ask your readers about, thinking that perhaps some of them may have noticed the same peculiarities as myself. This case is in regard to drills, and the discovery was made some few weeks ago by myself; how many times it has been discovered before, I am unable to say, but, as I have never seen it in print, will give it for what it is worth.

While drilling steel with a small twist drill I noticed how the particles of steel adhered to the point of the drill, and seemed to stand out in much the same way as from the pole of a magnet. This induced me to test for magnetism with a compass, and the result was a little surprising; the point of the drill showed a decided south pole (attracted the north pole of the compass). After testing several drills that are used on iron and steel exclusively, and finding the same results, I tried some that were used solely on brass. These did not show polarity in nearly the same degree as those used on the magnetic metals, but still showed magnetism in a slight degree, the surprising feature being that the polarity was reversed. Then some new drills were tried, but without result as far as magnetism goes; for, while attracting the needle, as will any magnetic metal, they showed no polarity, at least not marked enough for detection with an ordinary pocket compass.

Flat drills showed the same results, so it can hardly be said to be the steel from which

they were made, as nearly all kinds were represented. The only explanation would seem to be, contact with a magnetic metal in the one case, and with non-magnetic in the other. To sum it up: Drills used on steel and iron (magnetic metal) become magnetic, with their points *north* poles. Drills used on brass (non-magnetic metals) become magnetic, with their points *south* poles. Of course, it will be understood that the reverse ends of the drills are of opposite polarity.

The question is, What causes the appearance of magnetism, and why is it reversed in the two cases? If any of your readers have had any similar experience, it might be interesting to compare notes. Magnetism is a queer as well as very interesting study, and this case, in particular, seems queer to the writer. Who can explain?

FRED. H. COLVIN.

How Shall He Build His Tool Chest?

Editor American Machinist:

Like Mr. Franklin, I am about to have a tool chest made, and, like him, would like a little more light on this particular subject. The enclosed sketch, which explains itself shows the handiest arrangement which I have seen yet. I would put the fine tools in the drawers, and the hammers, wrenches, chisels, etc., in the top. The size and number of drawers would best be determined each one for himself. In mine, I propose to have one drawer for micrometer and vernier calipers and standard gauges, another for calipers, scales, dividers, etc., and so on, each tool having a place, and each tool in its proper place when not in use. This arrangement, I think, will utilize the space to the best advantage, and each tool will be forthcoming when wanted, without any unnecessary delay. If any of your readers know of anything better than this, let us hear of it.

H. D. PENNEY.

MR. PENNEY'S TOOL CHEST.

Editor American Machinist:

I want to tell L. W. Franklin how I built my machinists' tool chest; size 16 inches vertical; 12 inches width; 25 inches long, inside measure.

Seeing the evident inconvenience of chests as usually built with lid at top, causing the lifting out of tools and trays to get at the lower parts of chest, and the binding and cramping of sliding tray-boxes, when loaded with tools, I said my chest shall open at the side by a drop lid to a horizontal position, being held when open, by folding metal strap at each end, the lid making a handy table on which to arrange tools or small work, to write or draw after having first elevated the chest to the height of a common work bench, there to remain off the floor out of the dust to the end of the job.

Now as to inside arrangement. Beginning at the top, first 4 inches is a row of pigeon-holes 4 inches deep by 5 inches broad, reaching from back of chest 9 inches forward, leaving 3 inches space in front. Next below a row of drawers 3 inches deep by 5 inches wide, and 9 inches long. Next another pair of drawers each 12x9x4 inches deep. In one I keep papers, drawings, and copy of the AMERICAN MACHINIST, current number, when not in use. In second drawer I make place for 12-inch scale, straight-edge, bevel, etc.

The space of 5 inches at the bottom leave unobstructed, full size. The space of 3 inches in front of drawers will be found very convenient; you can put in overalls and jacket when going on a journey.

Build the chest with good handles and casters, and sunk panels at ends and sides. Have raised panel on top side door, cut in, not overlapping, and it will the better stay right-side up on its travels.

L. D. TOLIVER.

Boring a Taper—Commutators.

Editor American Machinist:

Thinking that as a "shop kink" the following method of boring a taper hole might be of interest to your readers, I send you a description of it, as the only practical one that offered at the time.

The lathes equipped with appliances for boring and turning taper, being in use, I was forced to extemporize.

The piece to be bored was intended for an expansion arbor.

The chuck was first put on, and the piece to be bored inserted and bored to nearly the finished size, after which the chuck was removed with the bored piece still in it. The taper arbor was then put on the centers, and a bevel set to correspond with the taper. The arbor was then removed, and another arbor, smaller in diameter, was inserted, the tail block being set over enough to make the arbor correspond to the bevel.

The chuck being then replaced, the tool was inserted in the tool-post, so as to project through the hole, the tool-post bearing against the arbor.

There being some play to the cross-slide, it was further increased by loosening the nut of the hand-wheel, and driving off slightly.

Means were also provided for holding the tool-post in contact with the arbor.

The effect of this arrangement would be the movement of the cross-slide towards or away from the center of the hole, according to the movement of the carriage on the ways of the lathe.

Modifications of this arrangement and improvement in the details will readily suggest themselves to any one. The arrangement, so far as is known, is original with the writer, and the thought that it might be useful to some one has led me to put it on paper.

The practice in this shop, and the one which has been found to give the best results in turning copper commutators, is to use a round-faced tool forged much like a diamond point, with the exception of its being round, set very high in the tool-post, and with the cutting edge of the tool beveled back as much as strength will admit, in order to get a knife-like cut.

Sandpaper only is used to finish after turning, although for a fine finish, and in order to get a smooth and hard wearing surface, they are sometimes burnished. It has been my experience with tempered copper that it is considerably harder to work than drawn or forged copper. The bars seem very tough, bend comparatively easy, but are destructive to tools to a much greater extent than any other I have used for the purpose.

ALLEN HAMMOND.

Use Sand Paper.

Editor American Machinist:

I see in your issue of April 30th a suggestion from A. A. Cross on the subject of keeping commutators true, in which he says use fine emery cloth. If the use of emery cloth is followed to any extent it will surely cause trouble. The oxide of iron contained in emery will short-circuit the commutator bars, and cause bad sparking. Fine sandpaper should be used always on commutators.

SAMUEL M. GREEN.

Editor American Machinist:

Mr. A. A. Cross gives a neat and handy device to keep commutators true, but would suggest that emery is bad stuff to use where there is any wearing surface, as it will always remain. Sandpaper would be preferable, as sand will not penetrate like emery, nor remain sharp so long and give trouble afterward.

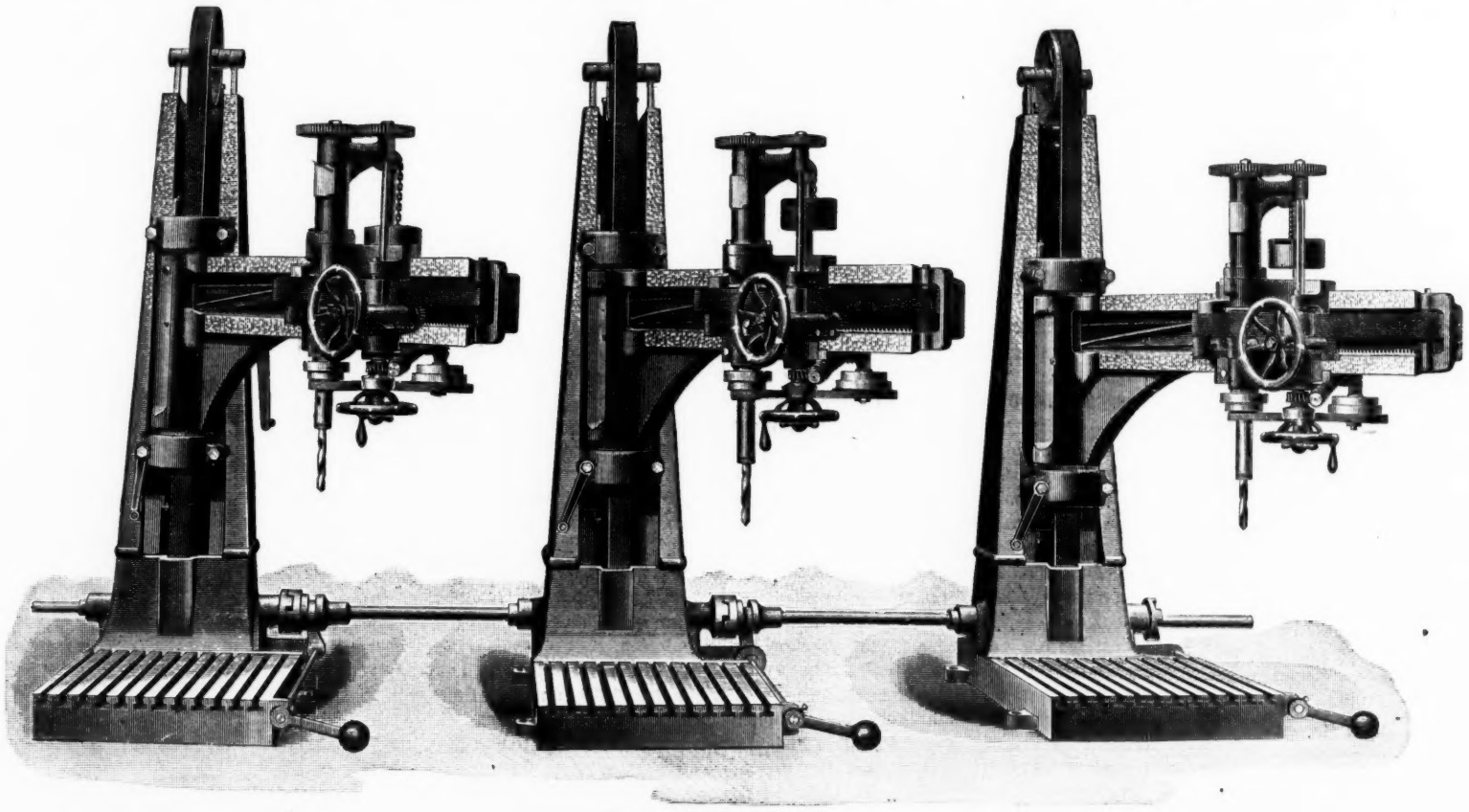
W. E. CRANE.

Radial Drills Arranged in Gangs.

We give on this page an illustration showing an arrangement of radial drill presses especially for bridge or iron shipbuilding, and other work of like character where it is desirable to do the work expeditiously and without moving it about.

The machines are built by Alfred Box & Co., of Philadelphia, and are much the same as their regular radial drills as built for general work, but are arranged to be placed on two I beams on which they can be adjusted to any desired distance from each other, each machine being driven independently by means of a clutch from a splined shaft which passes along at the back.

The machines are of such proportions that each one can be operated anywhere in a space 4 feet by 6 feet, and thus by placing them 6 feet apart on the beams work up to 4 feet in width can be operated upon at any point without the necessity for moving it, and as there is an automatic feed for all the spindles they can be operated simultaneously, the number of men required depending, of course, upon the depth of the holes to be drilled. By using seven of the machines in a gang, plates or girders up to 50 feet in length can be drilled, and for such work they have been found by trial to be very efficient. The main driving shaft is splined its entire length, so that any desired spacing of the drills may be had, and the clutches are readily thrown in or out from the front of the machines. There are eight changes of speed for the drills, with six changes of rate of feed, three of these being by means of the stepped feed pulley, while the others are had by reversing the gears at the top of the spindle. The faster speeds are very coarse, and are used mainly in reaming punched holes. The particular advantage in the use of radial drills for this work is that, no matter how the holes may be laid out—whether in straight lines or in any other way—they can be reached with the greatest facility.



RADIAL DRILLS IN GANGS.

C. O. Sine calls attention to a slight error in figures in his article "Traction Engines on Inclines," in our issue of April 23. In fourth column, page 6, the reading should be 33.75° and 11.25° instead of 33.66° and 11.33°. The error was of no particular importance.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
96 FULTON ST., NEW YORK.

PUBLISHED WEEKLY AT
96 Fulton Street, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
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$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
The International News Company,
BREAM'S BLDG'S, Chancery Lane, LONDON, E. C., ENG., will receive subscriptions for the AMERICAN MACHINIST, at 16 6 per annum, postage paid.

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Subscriptions received in Australia by W. WILLIAMS, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, MAY 14, 1891.

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The Government as a Buyer of Machinery.

While the recent purchase of heavy tools by the War and Navy Departments has been, upon the whole, beneficial to tool-building interests, it is easy to detect a certain feeling of dissatisfaction which has grown up, not with the government officials personally, for they are credited with being courteous and fair minded gentlemen, but with the system by which bids are received and contracts given.

The sentiment seems to prevail that the chief difficulty results in the specifications upon which bids are asked being made much too minute—so minute, in fact, as in some cases to defeat the very object aimed at, *i. e.*, to secure bids based upon the most advanced modern practice.

This is said to result often from the efforts of some interested person representing to the engineer officer that certain features and certain proportions, etc., are really essential to a satisfactory machine of the kind wanted.

Upon the strength of these representations specifications are made out and bids asked upon them, when it may be discovered that some of the things specified are tied up by patents, or require a precise following of some certain builders' peculiar or characteristic styles of construction, thus, in some cases, actually shutting out bids from concerns who could, and undoubtedly would, if given sufficient latitude, furnish tools equal or superior to those so minutely specified.

The advance made in the art of heavy tool building has been quite rapid of late, and only he who devotes considerable attention to the matter can keep track of it or be at all sure that he knows what constitutes the latest and best practice in any given line.

An illustration of this occurred not long ago, when the government asked bids on a lathe, specifying, among other things, its weight, the object being, of course, to secure the heaviest construction. A prominent firm of builders found, upon examining these specifications, that their regular lathe of the nominal capacity specified weighed just 50 per cent. more than the specifications called for. At the same time, other features were specified in detail, which shut out this concern, or, at least, made it seem unadvisable for them to put in a bid, though their construction, rather than that specified by the government, undoubtedly represented the latest and best practice in that line.

Another tool builder found that when a certain hydraulic machine, of which he made a specialty, was wanted for use in shipbuilding, specifications had been made out to fit the product of another builder who had been of late devoting his attention to other lines of work, and had fallen behind the latest practice in that particular line.

Weight was specified here, too, and the specialist who secured the contract declared that, had it happened that the normal weight of his machine had fallen below the specified weight (the reverse, however, being actually the truth), it would not have been necessary for him to change his design at all, but simply to have put the extra required weight into the legs by making new patterns for them only. Thus the requirements could have been fulfilled by a machine no better, if indeed as good, on the whole, as his regular production.

The present plan of procedure may be the best one possible, but there is no doubt that private individuals, in buying tools, get a better result by a plan entirely different, and that plan is to simply state to the builders what the proposed tools are to do, and then to consider which builder's tools best fill the requirements, and, all things considered, are best worth the price asked. No such thing is thought of as confining the proposals of all builders to a certain type and details of construction which may or may not be the best, and then buying the cheapest offered.

The plan followed by private individuals or firms could not, for obvious reasons, be followed by the government, but the nearer the approach to it, the more satisfactory the whole business will become, probably.

The ideal plan would be to merely state what the tools are required to do, and ask builders to submit drawings and prices, no marks of any kind being upon the drawings to indicate their origin. Then let a board of experts, composed of officials and civilians, pass upon the matter, and award the contract, not to the lowest bidder necessarily, but to the one making the best proposition, all things considered.

The main difficulty with this plan would probably be that engineers qualified to pass judgment upon the merits of the different designs submitted would necessarily be sufficiently familiar with the practice of the various builders to identify their designs at sight, and thus the prime object in leaving off identifying marks would be defeated But, nevertheless, it seems not unlikely that such a board would be able to come to a decision in most cases, which would cause no more criticism than the present plan, and the chances would be better for the best tools being put in, at a fair price; which is what we understand the government desires.

By this plan there would be a decided stimulus to the production of new and improved designs, whereas under the present plan the tendency is distinctly the other way, or to prevent new designs being submitted.

For the Information of Two Correspondents.

Mr. Charles F. Perry, of Ashburnham, Mass., writes us: "Please inform me how many years your paper has been published and what its ratio of gain is yearly. I have chosen for a graduating thesis 'The Coming Mechanic,' and I want to prove that one of the causes of the present high standing of mechanics, and the probable prosperity of the coming mechanic, is due, in a high degree, to the scientific papers of to-day. . . . I am desirous of making a true statement regarding some of the leading papers at home and abroad."

For the information of this correspondent, the first appearance of the AMERICAN MACHINIST was as a monthly in November, 1877. It started, of course, with no circulation, though only a few months were required in which to convert its opening edition of 5,000 copies into a regular paid circulation.

Its first appearance as a weekly was on June 28, 1879, and its first edition as a weekly was 7,000 copies. Since then, its growth has been quite constant until within the past year or so, during which it has increased in circulation more rapidly than ever before in its history. At the present time its regular weekly circulation is 20,000 copies, 22,000 copies being printed each week to cover all purposes. We trust the foregoing will supply the information our correspondent is in search of, so far as this paper is concerned.

Professor C. V. Kerr, Fayetteville, Ark., writes: "Have you such a thing as a list of engineering and technical schools to whom you supply the AMERICAN MACHINIST free? If so, we should be happy to have you put us on that list."

Replying to this, we have no such list as is referred to in the above query. A few complimentary copies are sent free to contributors, and the usual custom of a copy free to advertisers and exchange with contemporaries is followed. Beyond this, the edition of the AMERICAN MACHINIST is subscribed and paid for, or bought from the news stands. We could readily mail several thousand copies free to the various institutions and societies of the country, and no doubt, in many instances, it would be a worthy thing to do. But we are not desirous of having a circulation based upon such a disposition of our edition. We take satisfaction in believing that the AMERICAN MACHINIST is considered worth its price by those who subscribe for it or buy it, and we have the further satisfaction of believing that a paper that is paid for is read by those who receive it.

Literary Notes.

BOILER MAKING FOR BOILER MAKERS. A practical treatise on work in the shop. Showing the best methods of riveting, bracing, and stay-ing, punching, smithing, etc., and the most economical manner of obtaining the best quality of output at the least expense. By W. H. Ford, M. E. Second edition.

This little work is entirely practical in character. Its opening chapter treats on the kinds of material used in boilers, after which the forms of boilers, and computing their strength, is taken up. Then follow chapters on riveted joints, bracing and staying, flanging, welding plates, smithing, punching, drilling, trimming, cold bending, setting up, calking, tube setting, fittings, and testing boilers. The author writes from a practical standpoint, and does not lose sight of the fact that the book is intended for boiler makers and practical men. It is written in a plain, brief, intelligent and interesting manner, and illustrated wherever required to convey a clear understanding of the subject. The inexperienced who seek for information of a practical nature relating to boiler making, cannot fail to be benefited by a perusal of the book. It is published by John Wiley & Sons 53 East Tenth street, New York. The price of the book is $1.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(212) R. D., Elizabeth, N. J., asks: How are the diameters of step pulleys determined? *A.*—See our issue of December 1, 1888.

(213) C. C. L., Washington C. H., O., writes: I wish to take out a license for handling steam; please inform me of the proper steps to proceed. *A.*—The laws in regard to licenses are not the same in all localities. We should advise you to apply to the Police Department in your locality.

(214) W. L. B., ——, Mass., writes: Please inform of the weight and dimensions of a balance wheel for a jig saw making 1,400 strokes of 4 inches per minute. *A.*—The size of wheel will depend on the weight of the reciprocating parts, and the general design of the machine, of which you have said nothing; we therefore cannot advise you correctly.

(215) F. L., Maplewood, N. J., asks: How many sections are there in a pattern of a locomotive cylinder? *A.*—The pattern consists of a number of parts, and core-boxes; the number will depend on the design of cylinder; for instance, some cylinders have one-half of the saddle cast to them, and others have a loose saddle. The number of parts and core-boxes also depends on the facilities for doing such work in the foundry.

(216) E. F. B., ——, asks: What is the proper size of ports for an inclined engine 36x42 inches; piston speed, 196 feet per minute? *A.*—The area of the steam port should be 30 square inches; hence we should make steam ports 1½ inch wide and 22 inches long; and the exhaust port 3x22 inches, provided the design of engine will admit this proportion of width to length. If the lap is not excessive, and if the bridges are comparatively wide, the width of the exhaust port can probably be somewhat reduced.

(217) H. M., Two Harbors, Minn., writes: I was interested in your description of the stay tubes in the gunboat "Concord," given in your issue of December 18th, 1890. I enclose a sketch of one, to show the only way I can see that they can be screwed in at both ends. I would like to ask if the sketch is correct? and why could not a tube of this kind be used in a locomotive boiler? *A.*—Your sketch is nearly correct; one end of the stay tube is swelled out, making the outer diameter of the end larger than the outer diameter of the tube, but the inner diameter is not increased as you have shown it. Stay tubes are not needed in locomotive boilers.

(218) J. W. C., St. Paul, Minn., asks: Are hollow shafts used to any extent for screw propellers on steamships? *A.*—Hollow

shafts are used to quite an extent in the U. S. Navy. Steel shafts are generally made hollow by boring; the purpose of this is not only to obtain the maximum strength with the minimum amount of material, but also to obtain some assurance that the shaft is sound. 2. Have any of the principal Atlantic steamers hollow shafts? *A.*—We believe not. 3. Please give the names of any notable examples, with diameters, if possible. *A.*—See our description of the U. S. gunboat "Concord," in our issue of December 18, 1890.

(219) T. Q., Paducah, Ky., writes: Please state if the following dimensions are correct; if not, please give the proper sizes: Cylinder, 18 inches diameter, 20 inches stroke; number of revolutions, 125 per minute; main shaft, 6 inches diameter; crank-pin, 3½ inches diameter by 4 inches long; connecting rod, 53 inches from center to center; throw of eccentric, 4 inches; steam pipe, 3½ inches diameter; steam ports, 1⅝ inch by 11 inches; exhaust port, 3x11 inches; bridges, ⅝ inch thick. *A.*—The diameters of the shaft and crank-pin will depend on the steam pressure, which you have not given Assuming the initial steam pressure to be 80 pounds per square inch, we should make the crank-shaft 8½ inches diameter; and for an overhung crank we should make the crank-pin not less than 5 inches diameter and 5 inches long. The steam pipe should be 4½ inches diameter; steam ports, 1¼x14 inches; exhaust port, 2½ x14 inches; and the thickness of the bridges should be about equal to the thickness of cylinder so as to insure a good casting. Travel of valve, 5½ inches

(220) R. R., Muskegon, Mich., writes: I would like to know how to figure out the horse-power of a boiler. *A.*—The term "horse-power of a boiler" is a very vague term. The unit of horse-power for boilers is not fixed except by arbitrary agreement among the parties concerned, the basis differing according to the nature of the work to be done by the steam. Many boiler makers rate the horse-power by the number of square feet of heating surface contained in the boiler. There would be no practical objection to this rating, if the heating surface was a thing of specific value. Boilers not only vary among themselves in the value of heating surface, but it is not of equal value in the same boiler. It is therefore evident that no exact rating of a boiler can be made from a knowledge of only its heating surface, yet, as it is convenient and necessary to make some arbitrary rating, the following may be useful; it is used in many boiler shops. For cylinder boilers allow 9 square feet of heating surface per horse-power; for flue boilers, 12 square feet; and for tubular boilers, 15 square feet of heating surface per horse-power. Hence, if the total heating surface is known, divide it by 9, 12 or 15, according to type of boiler, and the quotient will be the horse-power of the boiler. If a boiler is tested, and a statement of its horse-power desired, without regard to whether it is to supply its steam to drive an engine or for other purposes, then it is agreed among the majority of experts of the United States to consider 30 pounds of water per hour, evaporated, at 70 pounds pressure, from 100 degrees, as a horse-power. This standard was adopted by the judges at the late Centennial Exhibition, and is considered to be fair for both boilers and engines. Some engineers use an equivalent standard, namely 34½ pounds of water per hour, evaporated, from and at 212 degrees.

(221) N. P. B., Olean, N. Y., writes: I am forcing car wheels on axles with a screw 3 inches diameter, two threads per inch. Two men, weighing at least 150 pounds each, spring on a lever 7 feet long at the end of the screw. What will be the pressure per square inch on the end of the axle? The bore of the wheel is 2½ inches. Please give rule for computing the same. *A.*—The data given in the problem is very indefinite; it is impossible to determine from your statement the force which the men exert; you also omit to state the point at which the men apply their weight. To show how problems of this kind can be solved, we shall assume that the combined force of the two men is equivalent to 200 pounds applied at the end of the lever; the distance from the center of the screw to the end of the lever, or the point at which the force is applied, is 7 feet. It is obvious that, when the end of the lever describes a complete circle, the end of the axle will have moved through a distance equal to the pitch of the screw. Now the circumference of a circle described with a radius of 7 feet is 43.98 feet, and consequently the work done by the men during one complete turn of the screw is equal to $43.98 \times 200 = 8{,}796$ foot-pounds. If we now assume that there is no friction, then the work expended at the end of the screw will be equal to the product of the pitch of the screw into the pressure at the end of it. The pitch, in this case, is equal to ½ inch; this must be reduced to a fraction of a foot, because we have taken the circumference in feet; hence the pitch is equal to .0416 of a foot. Now, the product of the pitch into the pressure at the end of the screw must be equal to the work done by the men; hence, if we denote the pressure at the end of the screw by p, we have

$$.0416 \times p = 8{,}796,$$

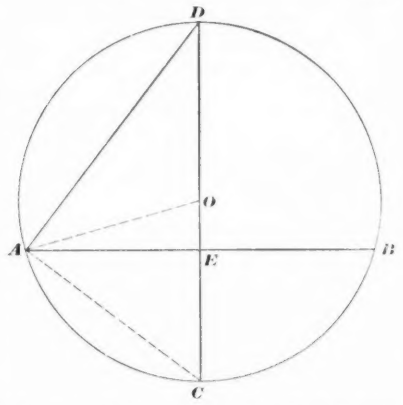
consequently,

$$p = \frac{8{,}796}{.0416} = 211{,}442 \text{ pounds.}$$

But here we have not taken friction into account, which greatly modifies the result. From 65 to 70 per cent. of the total work is expended in overcoming friction; let us assume that it requires 70 per cent., we have then $211{,}442 \times .70 = 148{,}009.4$ pounds which are lost in overcoming friction, so that only $211{,}442 - 148{,}009.4 = 63{,}432.6$ pounds pressure on the end of the screw is obtained. The cross sectional area of a 2½-inch axle is 4.9 square inches, hence the pressure per square inch is

$$\frac{63{,}432.6}{4.9} = 12{,}945.42 \text{ pounds.}$$

(222) W. S. C., Watertown, N. Y., asks: Do the inside drivers of a locomotive slip when running over a sharp curve? I think the inside wheels have to support the greater weight, and they will, therefore, have more adhesion. *A.*—In running over a curve at any considerable speed, the centrifugal force carries the weight supported by the springs towards the outer rail, and, consequently, more weight will be thrown on the outer wheels than on the inner ones, as you have assumed; this, of course, increases their adhesion, and therefore they will not be as liable to slip as the inner wheels. For comparatively slow speeds it is probable that all the wheels slip more or less. 2. In a given



circle, a pendulum $A\ D$ is suspended from a point D in the circumference. The length of the pendulum is given; it is required to find the length of the arc $A\ C\ B$, and the chord $A\ B$. Please give formula for computing the same. *A.*—To show clearly how to compute the length of the arc and chord, it will be best to take an example. Let $A\ B\ C\ D$ be the given circle whose diameter $D\ C$ is 5 feet; and let the length of the pendulum $A\ D$ be 4 feet. Our first step will be to find the length of $D\ E$. A triangle $A\ C\ D$ inscribed in a semi-circle is a right-angled triangle, and therefore, according to the demonstrations in geometry, the line $A\ D$ is a mean proportional between the diameter $D\ C$ and the segment $D\ E$. Hence, divide the square of $A\ D$ by the diameter $D\ C$; the quotient will be the length of $D\ E$, thus, $\frac{4 \times 4}{5} = 3.2$ feet, which is the length of $D\ E$. Now, knowing the length of $D\ E$ and $A\ D$, we can easily find $A\ E$ by subtracting the square of $D\ E$ from the square of $A\ D$ and extracting the square root of the remainder, thus: $(4 \times 4) - (3.2 \times 3.2) = 5.76$, and the square root of 5.76 is 2.4, which is the length of $A\ E$ in feet, and twice this, or 4.8 feet, is the length of the chord. Now it simply remains to find the length of the arc $A\ C\ B$. Dividing the $A\ E$ by $A\ D$ we obtain the sine of the angle $A\ D\ E$, thus, $\frac{2.4}{4} = 0.6$, which is the required sine. Looking for this sine in a table of natural sines we find that the angle $A\ D\ E$ contains 36°, 53′. The angle $A\ O\ C$ at the center O contains twice as many degrees, or 36°, 52′ × 2 = 73°, 44′. The whole circle contains 360 degrees; its circumference is 15.708 feet, hence the length of the arc $A\ C$ is found by the following proportion: 360° : 73°, 44′ :: 15.708 : $A\ E$; hence $A\ E = \frac{(73°, 44' \times 60) \times 15.708}{360 \times 60} = 3.217$ feet, and twice this, or 6.434 feet, is the length of the arc $A\ C\ B$.

(223) J. H. B., Minneapolis, Minn., writes: Be kind enough to give me a rule for ascertaining the power of a locomotive for hauling a load of a given weight at 5, 10 or 15 miles per hour. *A.*—The tractive power of a locomotive is usually found by the following rule: Multiply the square of the diameter of the cylinders in inches by the mean effective pressure in pounds per square inch, and by the stroke in inches; divide this product by the diameter of the driving wheels in inches; the quotient will be the tractive power. This rule can be expressed by symbols: Let T denote the tractive power or pull at the rails in pounds; d, the diameter of the cylinders in inches; p, the mean effective pressure in pounds per square inch; S, the stroke in inches; and D, diameter of driving wheels in inches. We have, then:

$$T = \frac{d^2 \times p \times S}{D}$$

To show the application of this rule, we will take the following example: The diameter of cylinders of an eight-wheeled engine is 18 inches; stroke, 24 inches; diameter of drivers, 61 inches; mean effective pressure per square inch, 90 pounds. Now, substituting for the symbols their values, we have:

$$T = \frac{18^2 \times 90 \times 24}{61} = 11{,}472 \text{ pounds.}$$

This result tells us that the engine is capable of exerting a pull of 11,472 pounds. To overcome the resistance due to friction of American cars, it will take a force of about 6 pounds per ton (of 2,000 pounds) of the weight of train to move it slowly on a level and straight track after it has been started. But the engine is capable of exerting a pull of 11,472 pounds; it can, therefore, move at a slow speed a train of $\frac{11{,}472}{6} = 1{,}912$ tons. As the speed increases, a greater force will be required to overcome the resistance of the train, and since the tractive power of the engine remains the same, it follows that the weight of train must be reduced. The resistance due to speeds is found by the following empirical rule: Divide the square of the speed in miles per hour by 171; the quotient will be resistance in pounds per ton of train due to the speed only, and this must be added to the resistance due to friction. To illustrate: What will be the weight of the train which the engine can haul at a rate of 25 miles an hour? Here we have $\frac{25 \times 25}{171} = 3.6$ pounds per ton due to the given speed. Adding this to the resistance due to friction we have a total resistance of $6 + 3.6 = 9.6$ pounds per ton. Therefore the weight of train which the engine can haul at the given speed is $\frac{11{,}472}{9.6} = 1{,}195$ tons on a level and straight track. Whether the engine can really employ its whole tractive power will depend on the weight on the drivers; if the adhesion is less than the tractive power the engine cannot haul as heavy a train; the velocity will depend on the steam-generating capability of the boiler. From these remarks it will be seen that the results obtained by the foregoing computations hold true only for locomotives which are correctly designed for the work they have to do, and even for these the results should only be accepted as approximations, since the rolling and axle friction are affected by the varying condition of the rails as to the smoothness, dust and irregularities, and to different proportions between the diameters of wheels and journals, the kind of springs, the kind and quantity of oil used in lubricating, and to other minor considerations. It must also be remembered that, for regular service, allowance must be made for the resistance due to curves, running up grades, and starting a train, all of which will reduce the weight of the train as found by the foregoing computations.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

George B. Grant—Gear Wheels. See p. 20.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

N. Y. City Bolt & Nut Co., Limited.

See Sterling Elliott's ad. on page 12.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Drop Presses, Punches and Shears. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Ice and Refrigerating Machines. 155 sold, and all successful. David Boyle, 521 Monroe St., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 112 Liberty St., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Universal Vise Chucks. Pedrick & Ayer, Philadelphia, Pa.

Link Planer Attachments. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

$13.00 I. Dea L. Drawing Stands. The original. Send for postal. W. S. Rogers, Troy, N. Y.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Miller's Falls Co., 93 Reade St., New York, are building a Power Frame for their Star Hack Saw.

S. A. Smith, 23 So. Canal St., Chicago, Ill., agent for Appleton Mfg. Co.'s Emery Grinding Machinery.

"Roper's Engineer's Handy Book." $3.50 post paid. Theo. Audel & Co., 91 Liberty St., N. Y. Catalogue.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson St., Chicago, Ill.

Sterling Elliott has too many irons in the fire and wants to dispose of some of them. Address him at Newton, Mass.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N. Y.

"Twenty Years With the Indicator," by Thomas Pray, Jr. 10,100 sold. Price, $2 50. Order of bookseller; take no other.

Audubon Machine Works, New Haven, Conn. Electrical work, superior facilities. Builders of machinery, heavy and light.

Gould & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal St., Chicago, Western Agent.

A rare chance for a new family to adopt some children that have already cut their teeth. Address Sterling Elliott, Newton, Mass.

Most sensitive and durable Damper Regulator made; works within one pound. Send for circular. T. Kieley, 11 W. Thirteenth St., New York.

For the latest improved Eccentric Hook, Connecting Rods and Stub Ends, address T. C. Dill Machine Company, Philadelphia, Pa.

Self-adjusting Hand-Screw for pattern makers, cabinet makers and wood workers generally. Send for circular. Wm. H. Denney, Lancaster, Pa.

N. Y. City Bolt & Nut Co., Limited, 33 and 35 Desbrosses St., N. Y. City, manufacturers of Machine Bolts of every description. Write for estimates.

25″ 32′ 37″ 42″ "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

DuBois & DuBois, Patent Attys., 715 11th St., Washington, D. C., procure first-class patents. Send stamp for illustrated pamphlet, "March of Invention," containing valuable information, and list of references.

Patent Soliciting of High Class.
D. Walter Brown, Counsel in Patent Cases,
31 Nassau street, New York.
Send for Brief History of Patent Legislation.

Foot and Power Presses for Metal, Paper and Leather. Perforating Dies a specialty. Estimates given for special machines or dies. Edwin B. Stimpson & Son, Manufacturers, 31 Spruce St., New York.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo, cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt St., New York

Our large Catalogue of Scientific and Practical Books mailed free to any address. It embraces works on more than fifty different subjects; is subdivided, enabling to refer to a particular subject. Norman W. Henley & Co., 150 Nassau St., New York.

De Lamater Screw Propeller Wheel, made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc Location and equipment well adapted for Heavy Steamship Repairs.

Club Rates.—If no one is getting up a club for the AMERICAN MACHINIST in your town or establishment, send for Circular of New Club Rates, and try it yourself. Address AMERICAN MACHINIST, 96 Fulton St., New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton St., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2, postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

MANUFACTURERS

C. F. Pekor is reported as about to erect a machine shop at Columbus, Ga.

The East Birmingham (Ala.) Smelting Works is putting in additional machinery.

Efforts are being made for the establishment of an iron foundry at New Lewisville, Ark.

The Davis & Furber Machine Company's foundry, North Andover, Mass., is being enlarged.

The capacity of the Calumet cotton factory, at Mammoth Springs, Ark., is to be doubled.

Douthat, Bell & Co. have, it is reported, established a machine shop at Fayetteville, Tenn.

The Harrisburg Boiler and Manufacturing Works, at East Harrisburg, Pa., will increase capacity.

The South Baltimore (Md.) Car Works Co. is to increase its capital stock from $200,000 to $300,000.

The E. W. Bliss Co., of Brooklyn, N. Y., are about to erect a 6-story addition to their machine shop.

The Bates Steel & Iron Company, capitalized at $100,000, have been incorporated at Columbus, Ohio.

It is stated that J. Alston will at once erect machine shops in Greenwood, S. C., at a cost of $11,000.

A hardware manufacturing company contemplate the establishment of a $30,000 plant in Norfolk, Va.

C. F. Kane, of Martin's Ferry, Ohio, has established a branch machine shop in Mannington, W. Va.

The Gilkerson Machine Company, Homer, N. Y., has recently filled an order for planer chucks for Russia.

The Michigan Rolled Steel Wheel Company, of Detroit, has been incorporated, with a capital of $50,000.

C. D. Beckwith, of Paterson, N. J., is investigating with a view of erecting a rolling-mill in Baltimore, Md.

A new shop, 115x116 feet, two stories, is to be erected by the Whitin Machine Company, Whitinsville, Mass.

Considerable new machinery is being added to its plant by the Hampden Braiding Company, Springfield, Mass.

A $250,000 plant, for the manufacture of cotton compresses, is reported as to be erected at Harriman, Tenn.

The Industrial Iron Works, at Bay City, Mich., are preparing to build an addition, 255x90 feet, to their works.

A nut and bolt factory, a canning factory and steel spring works are reported as to be erected at Oxanna, Fla.

The Michigan Rolled Steel Wheel Company, of Detroit, Mich., has been incorporated, with a capital of $50,000.

A foundry and car wheel works will be erected in Dalton, Ga., this summer by the Dalton Development Company.

The Paige Tube Company, of Warren, Ohio, will erect a foundry, 50x75, for the purpose of doing their own casting.

The Beecher Furnace and Foundry Company has been incorporated, at Shelby, Ohio; capital, $25,000; H. M. Dick, president.

The Kansas City, Watkins & Gulf Railroad Company is reported as to erect car shops and roundhouse at Lake Charles, La.

A stock company, with a capital of $25,000, is being formed to establish a machine shop and foundry at Middleville, Mich.

The South Florida Foundry and Machine Works, Orlando, Fla., will soon put in an outfit for the manufacture of tubular boilers.

At Talladega, Ala., the Alabama Land, Iron and Furnace Co. are making preparations to commence the erection of a 125-ton furnace.

The cotton-mill project at Hickory Grove, S. C., is progressing fairly well, and about $20,000 is already pledged for the enterprise.

The Cork Pulley Covering Company, Baltimore, Md., issue a circular describing the advantages of its covering for all kinds of pulleys.

A company has been organized at Renfrew (Ala.) with a view of encouraging the establishing in that town of a rolling-mill and pipe works.

Shaw & Oliphant, silk manufacturers, Paterson, N. J., have received the plans for their new factory, which is to be erected at the Eastside.

A stock company will, it is stated, be incorporated to purchase, enlarge and operate the iron foundry of Kelly Bros., at Jonesboro, N. C.

H. E. Hawes is just starting in the machine business, at 143 Centre street, New York. He will build specialties, do experimental work, etc.

It is rumored that the Western & Atlantic Railroad Company will remove its Atlanta repair shops to Dalton, Ga., and erect a roundhouse.

It is stated that the Lattimore Machine Company, St. Louis, Mo., will build a new factory on East Elwood street, on land donated by the city.

The Puget Sound Wire Nail and Steel Co. has been formed at Tacoma, Wash.; capital, $200,000. Will locate in or near Port Gardner, Wash.

The Scott Machine and Hardware Company, at Denver, Col., are enlarging premises to double former size, and will put in several new tools.

The Anderson (S. C.) Iron Foundry and Machine Shop will be enlarged, and the making of sorghum-mills will be added. R. F. Diver is the owner.

The Bridgeport (Conn.) Machine Tool Works has opened a new office at 143 Liberty street, New York, room 230. Mr. N. B. Lyons is in charge.

The Arnold Electric Manufacturing Company has been incorporated at Chester, Pa., with $50,000 capital, to manufacture engines, machinery, plants, etc.

It is stated that Cornelson & Lucas have commenced work on the erection of an ice factory and cold storage plant to cost $30,000, at Gadsden, Ala.

A branch cotton and woolen finishing works is to be established at Chester, Pa., by J. G. Campbell & Co., of Frankford. New machinery will be put in.

The Standard Manufacturing Company has been incorporated, at Martinsburg, W. Va., to do general machinery business, by B. R. Harrison and others.

The Kincaid Manufacturing Company, of Griffin, Ga., which has declared a dividend of 6 per cent., has decided to put in $30,000 of new machinery in the mill.

T. H. Foster, of New York, proposes to erect steel car works at Henderson, Ky., with a capital of $200,000, if the citizens will put in $100,000 of the amount.

J. M. Curry, of Pittsburgh, Pa., and others, are investigating with a view of establishing works for the manufacture of railroad freight cars in Lexington, N. C.

It is stated that an iron and steel works company, in which R. P. Smith, of Houston, Texas, is interested, will establish a $750,000 plant at New Birmingham.

It is stated that $75,000 will be expended in improving and putting in operation the hardware factory of the Alabama Builders' Hardware Co., Ft. Payne, Ala.

Luker & Smith, of Russellville, Ark., have organized as the Russellville Foundry and Machine Co., and will establish the plant indicated by the company name.

E. H. Bramhall, of Bath, Me., is building a foundry, machine shop and wood-working shop, to be used in connection with his business of building steam yachts.

The Norwood Car Replacer Company will, it is stated, erect malleable iron works, at a cost of $100,000, in Ellicott City, Md., provided the citizens subscribe $25,000.

The capacity of the Bluefield Iron Works, at Bluefield, W. Va., it is reported, is to be increased. These works are owned and operated by W. A. Cather & Brother.

C. W. Osgood & Son have begun work on their new property at Bellows Falls, Vt. The machine shop will be pushed to completion as fast as is consistent with good work.

The Waukegan Engine and Machine Works has recently been formed at Waukegan, Ill.; capital stock, $3,000; incorporators, J. A. Craig, J. G. Malcolmison and George H. Powell.

The Brayton Motor Company has been formed at Chicago, Ill.; capital, $500,000; to make and sell the Brayton hydro-carbon engines; C. R. Holmes, G. L. Dickinson and Eugene White, incorporators.

A rolling-mill for the manufacture of bar-iron and cotton ties is to be erected this year at Anderson, Ind., under the auspices of Cleveland parties, who have made arrangements for a site there.

At Orlando, Ark., the Lownes Manufacturing Company has been organized, to operate an iron foundry and machine shops, and to manufacture the Lownes pipe wrench; capital stock, $300,000.

A charter has been issued to the Eureka Nut Lock Company, of Pittsburgh, Pa., with a capital of $30,000; directors, Wm. H. Hays and John W. Parks, Pittsburgh, and David E. Park, Allegheny City.

T. C. Botsford and J. N. Hurt have selected three acres of ground in Akron, Ohio, on which to build their proposed steam car heating works. The buildings will be 80x300 feet, and another 60x200 feet.

Pennsylvania capitalists are making arrangements with the West End Improvement Co. for the erection of wrought-iron pipe works in Hagerstown, Md., and a stock company is to be organized to operate same.

The Champion Blower & Forge Co., Lancaster, Pa., has issued a revised catalogue of forges, blowers, drills, and various other blacksmith's tools. The catalogue is fully illustrated, and brief description of tools is given.

J. J. G. McShane, Edwin Howland, G. H. Rogers and others, have incorporated the Henry McShane Manufacturing Company, at Baltimore, Md., to operate the McShane Bell and Iron Foundry. The capital stock is $1,050,000.

The National Malleable Iron Company, of Peoria, Ill., has been incorporated, to manufacture malleable iron and machinery. The capital stock is $100,000. The incorporators are A. Henry, A. C. Angler and George A. Willson.

The Cleveland Twist Drill Company, Cleveland, Ohio, has let the contract for a three-story, 40x115 feet, extension to their present works. This extension has been rendered necessary by rapidly increasing orders for twist drills.

Virgil Powers, J. A. Carlton and H. L. Johnson have incorporated, at Atlanta, Ga., the Carlton-Johnson Railway Signal Company, to manufacture the automatic electric block system of railway signals, etc. The stock is $100,000.

There is water-works agitation in Goffstown, N. H; Union City, Tenn.; Cincinnati, Ohio; Huntington, N. Y; Alexandria, La.; Halifax, N. S.; Madison, Ga.; Grand Rapids, Mich; Saginaw, Mich.; Mayville, N. Y.; Whitestone, L. I.

At Colorado Springs, Colo., the Rapid Transit Co. are about to add to their plant, and will build in connection therewith a machine shop, and equip the same with new and improved tools, among which are lathes, drill, wheel, press, etc.

H. D. Emerson, T. J. Creaghead, C. L. McCrea and others have incorporated, at Covington, Ky., the Creaghead Engineering Company, to manufacture all kinds of electric, mechanical and manufacturing appliances. The capital stock is $25,000.

The Chesapeake & Ohio Railroad Company (office, Richmond,) will, it is stated, erect machine shops for the manufacture of locomotives, engines and boilers, and shops for the building of freight cars, passenger coaches, etc., at Clifton Forge, Va.

An endeavor to organize a stock company for the purpose of establishing a foundry at Port Townsend, Wash., is being made, with good success. Among the interested parties we notice Charles Eisenbeis, A. I. Smith, J. A. Kuhn, E. S. Fowler and others.

The American Mining and Milling Machine Company, Chicago, is a new concern, to manufacture mining, milling and other kinds of machinery, with a capital stock of $1,000,000. The incorporators are William Armstrong, Frank B. Dyche and Lawrence Harmon.

The Trojan Car Coupler Company has been incorporated, at Troy, N. Y.; capital, $300,000. The trustees are H. T. Jennings, of Bergen Point, N. Y.; George C. Thomas, New York; C. P. Anderson, New York; F. S. Young, Troy, and Albert Seibert, of New York.

The Lownes Manufacturing Company will build a machine shop and iron foundry at Huntsville, Ala., to manufacture the Lownes patent wrenches, and do a general machine business. For further particulars address: Lownes Manufacturing Co., Box 336, Orlando, Fla.

The Smith-Courtney Company has been incorporated, at Richmond, Va., with G. A. Smith, president; T. L. Courtney, vice-president, and S. M. Price, secretary, to manufacture machinery, etc. The capital stock is to be not less than $75,000 nor more than $250,000.

The Toledo Bridge Company, of Toledo, Ohio, have been incorporated, with a capital stock of $100,000, to manufacture and construct bridges and structural iron and steel works. The incorporators are James A. Huston, G. P. Waddorf, L. E. Clark, E. F. Smith and E. W. Toleston.

A corporation, to be known as the Malden Machine Company, has been organized at Portland, Me., with a capital stock of $100,000, for the purpose of manufacturing machinery. The officers are: President, F. W. Sawyer, of Malden, Mass; treasurer, Charles T. Small, of Providence, R. I.

D. Saunders' Sons, Yonkers, New York, have brought suit for infringement of the re-issued patent No. 10,021, dated January 31, 1882, for improvement in pipe-cutting tools, which re-issue was assigned to them, and they notify those purchasing pipe-cutting tools that they shall prosecute all infringers.

The Pueblo Iron Foundry Company, F. P. Lehner, proprietor, at Pueblo, Colo., is erecting a machine shop, 44x160. This will be equipped with modern tools. The foundry department will be still further improved, and present capacity for melting iron doubled. When completed, 16 to 20 tons can be melted per day.

The Jennings Manufacturing Company have recently moved into their shop in the new four-story building, 213 and 215 Race street, Philadelphia, Pa. They will manufacture electric motors and do a general machine business. Mr. Jennings has had considerable experience in the line, and is well fitted for the business.

The manufacture of the Beimling testing machine, which we illustrated in our issue of February 5, has been taken up by J. E. Lonergan, 211 Race street, Philadelphia. He will manufacture the testing machines in a modified form, several details being altered and the machine generally improved from a mechanical point of view.

A reorganization of the Virginia Steel Car Company has taken place. Col. Robert Catlett has been elected president, instead of A. S. Buford, resigned; Mr. Foster elected vice-president, and Joseph A. Moore secretary and treasurer. The directors are Gen. Fitz Hugh Lee, Wm. A. Anderson, W. W. Green, of Chicago, and the officers of the company.

The Webster, Camp & Lane Machine Company, of Akron, Ohio, have added $15,000 worth of new tools to their machine shop equipment, and at present contemplate increasing the size of their plant by erecting two or more brick buildings of large dimensions. They are at present employing some 225 men in the manufacture of mining machinery and steam engines.

Many mechanics, and some other people, will be sorry to learn that Sterling Elliott, of Newton, Mass., the funny man of the regular machine business, is going out of it, to devote his entire time to the manufacture of his hickory bicycles. We do not want his bicycle business to come to grief, but hope the spirit will soon move him to go back to first principles.

A large force of men is at work in the erection of the new shops of the Toledo, St. Louis & Kansas City, at Frankfort, Ind. It is expected that they will be completed and equipped with machinery by July 1, 1891. They are all constructed of brick, resting on stone foundations, and will have slate roofs. A roundhouse, which will hold twelve locomotives, is already completed.

The Lodge & Davis Machine Tool Company, Cincinnati, Ohio, has issued a new circular of machine tools, in which a variety of tools of their manufacture are illustrated and described. Mechanics will be interested in these illustrations and descriptions, and those who have a sense of humor will laugh at the quaint comparison of a man to an engine lathe, evidently added to emphasize the fact that "A little nonsense," etc.

It is stated that T. T. Hillman, of Birmingham, Ala., will, at the meeting of the Tennessee Coal, Iron and Railway Co., in New York, submit to the directors a proposition for the construction of a steel plant at Ensley. This proposition is to utilize, for the steel plant's construction, the $5,000,000 of stock which the company owns in the Ensley City Land Co., together with $500,000 to be supplied by Mr. Hillman and his associates.

The Ticonderoga Machine Company, Ticonderoga, N. Y., organized a year ago to carry on the machine business of D. C. Bascom, is erecting an addition to the old machine shop, which will be a brick structure 80x144 feet. The building will be equipped with the latest machinery. The company will engage in the manufacture of mining machinery and a gas engine. The capital stock of the company has been increased from $30,000 to $125,000.

The Etna Iron Works, Limited, at New Castle, Pa., will soon commence to make a number of important improvements in their rolling-mill. The old nail plate train will be torn out and a new train built by the Lloyd-Booth Company, of Youngstown, Ohio, will be erected. Three new puddling furnaces will also be added to the present capacity. At their blast furnaces a new Witherow blowing engine is being erected by James P. Witherow, of Pittsburgh.

The Spang Steel and Iron Company, at Etna, Pa., have just completed the specifications for a new department to be devoted to all kinds of heavy government work. The new structure will occupy about two acres of ground, and work on the foundations for six open-hearth Bessemer melting furnaces and three heating furnaces will soon commence. The cost is estimated at $250,000, and when completed the entire works will occupy over twelve acres of ground.

Mr. Frank H. Ball, well known in connection with the steam engine bearing his name, announces the formation of the Ball & Wood Company, 15 Cortlandt street, New York, for the manufacture and sale of the Improved Ball Automatic Engine; also that the new company has purchased 4½ acres of land at Elizabeth, N. J., upon which it is erecting shops. Charles R. Vincent & Co., who have sold the Ball engine at the address given above, are interested in the new company.

The Chapman Valve Manufacturing Company, of Indian Orchard, Mass., which completed a large addition to its plant only a few weeks ago, is once more talking of enlarging, this time its pattern department being the one considered. It is proposed to build a brick story, 100x40 feet in size, on top of the present pattern building, which extra space would be devoted to this department. The work, while not absolutely determined upon, is likely to be done this summer.

There is now much activity among the manufacturers who are getting under way at the new town of Harvey, Ill. Ten car-loads of machinery recently arrived for the Buda Manufacturing Company. This is the concern which transferred their plant from Buda, Ill. They make steel castings extensively, and supply the Illinois Steel Company with large quantities. The machinery for the Harvey Steel Car Company is now in position, and steel cars of their new patent will soon be completed. This is a radical improvement in car building. The other enterprises at this new town are progressing rapidly.

The ground has been broken at Huntsville, Ala., for the building of the Dallas Cotton-mills, which will cost $1,000,000. The first great wing of the building will be 336 feet in length, 102 feet wide, and from three to four stories high. The stone foundation, owing to the immense amount of machinery the building will contain, will be made six feet wide. The immense engines will occupy a different wing, a separate department from wing No. 1. The engines will be of such power as to run all the machinery in the wing which is being now erected, and of those to be erected later. The mill, when in active operation, will employ 1,800 operatives, and operatives of a skilled class.

Eastern headquarters of the World's Columbian Exposition have just been opened in the Stewart Building, Broadway and Chambers street, New York City. Mr. Alex. D. Anderson, special commissioner, is in charge, and will at all times be ready to furnish any information in regard to exposition matters, placing the office at the service of the public in this respect.

Comparative Boiler Tests with Plain and Serve's Patent Ribbed Boiler Tubes.

During last month there were made twelve comparative boiler tests. Six of these tests were made with plain tubes in the boiler, and the other trials were made with Serve's ribbed tubes in the same. The boiler was of the ordinary upright tubular type, 42 inches diameter; furnace, 36 inches diameter and 24 inches high; tubes, 63 in number, 2¼ inches diameter and 6 feet long; grate surface, 7 square feet; fire surface, 287 square feet. Each trial lasted eight hours, and was conducted by H. B. Roelker, mechanical engineer, 22 Cortlandt street, New York. There were 32.35 pounds of wood and 150 pounds of coal used to kindle the fire, and to raise steam to 70 pounds pressure, after which the trial was immediately commenced. Steam was kept at 70 pounds pressure, and the water level at 7 inches in the glass as nearly as possible, and both were at these points at the end of the trial. During an extra trial the steam was kept at about 100 pounds pressure, so as to obtain a high draught and dry steam; the water level was about 3 inches in the glass. The soot scraped out of the plain tubes after six days trials was 2¼ pounds; that scraped out of the Serve's

tubes after six days trials was 3 pounds. The condensed results of these trials are given in the following table, as compiled by Mr. H. B. Roelker:

Pounds of Coal per 100 lbs. of water evaporated.				
Draught in inches of water.	Plain Tubes.	Ribbed Tubes.	Economy of Coal %.	Increase in Steam Generated.
Natural draught .....⅛	19.72	13.65	30.83%	18.03%
Forced draught .....½	16.7	13.21	21.08%	30.97%
Forced draught .....⅞	21.37	14.8	30.74%	46.46%

Increase by Serve tubes over plain tubes	Total Evaporation.	Evaporation per lbs. of Combustibles.	Extreme Evaporation.
Natural draught ⅛	18.03%	57.54%	8,460 lbs. for plain tubes.
Forced draught ½	30.97%	32 68%	14,000 lbs. for ribbed tubes.
Forced draught ⅞	46.46%	46 84%	Increase. 65.5 %

These results show that with the use of Serve's ribbed tubes quite an economy of fuel has been obtained.

A Serve's iron ribbed tube 2½ inches diameter has simply seven ribs running longitudinally along the interior surface of the tube; these ribs are placed at equal distances apart; they are ½ inch deep, and their average thickness is about equal to that of the tube. They are said to be much stronger to resist crushing strains than plain ones, and make very strong stay tubes. When used for this purpose the ends are thickened so as to admit of their being threaded. When used for tubes the ribs are allowed to extend to within three inches of the ends so as to leave sufficient room for expanding. These tubes are made in Liverpool, England, and sold in this country by Charles W. Whitney, 91 Fulton street, New York.

Pattern Making.

BY P. S. DINGEY.

SLIDE VALVE CYLINDERS.

Slide valve cylinders are made in a great variety of forms. I have chosen and represented here a plain and well-known type, of which Figs. 30, 31 and 32 are three views. Fig 31 is a cross-section through the steam chest and exhaust port, and Fig. 32 is a section through the steam port.

The way of making the pattern for this cylinder depends largely upon the size of it; if the diameter is to be say less than 12", the body of the cylinder may be built up solid, but when above that size it would be better to build the pattern with staves, as shown in Figs. 33 and 34. But one-half of the pattern is shown, which will be all that is needed for explanation. An extra thickness is glued on each stave large enough for turning the body of the cylinder to the required diameter, thus allowing the prints and the cylinder to be in one, which is far better than fastening on the prints. The flanges are made thick enough to turn the fillet on the back of them. They should be got out as shown in Fig. 35; this will prevent the shrinkage of the wood from affecting the flanges to any great extent.

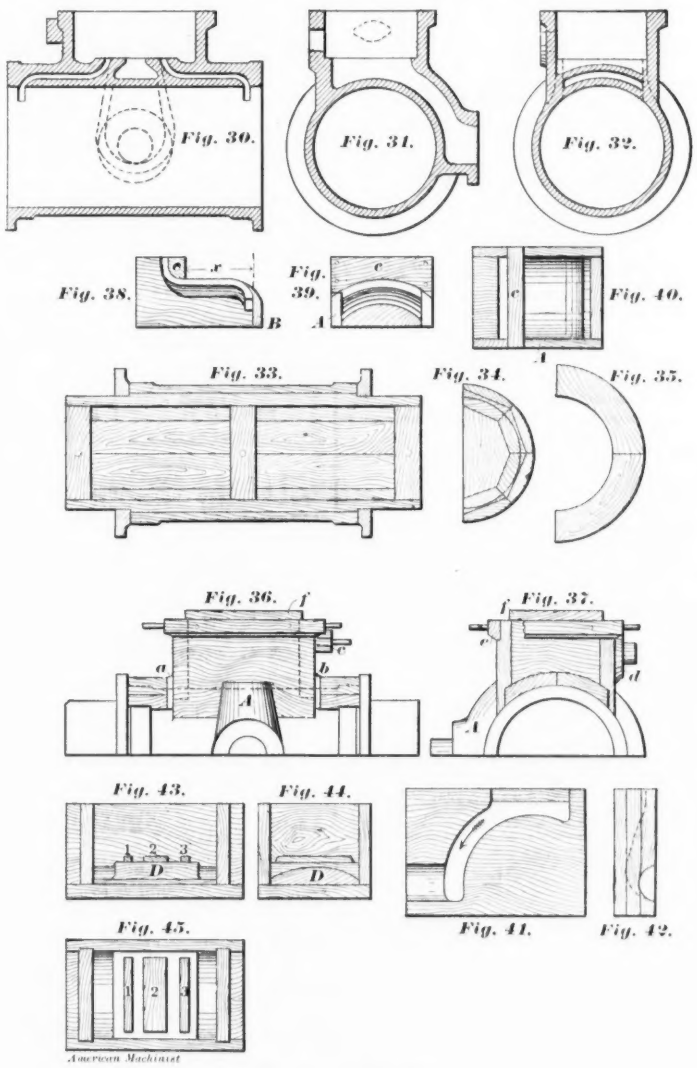
When the body of the cylinder is built up and turned, the steam chest is made and fitted on as seen in Figs. 36 and 37. The pieces for the exhaust passage *A*, and those to form a thickness over the ports, are also shown in place. The fillets at *a b*, Fig. 36, are cut out of a thickness that is inserted between the end of the steam chest and port pieces; there is no danger of the fillets coming out when made in this way.

The strips on the steam chest, which give an extra thickness of metal for the studs, are loose and put on with long dowel pins, so that they can be drawn separately, also the valve stem stuffing-box *e*, and the facing *d* around the steam opening are loose. The strips are shown at *e*, Fig. 37, let in about $\frac{3}{16}$" around the sides of the steam chest; this is done to prevent them from being rammed out of place after the dowel pins have been taken out. The core print *f* should be doweled on, because if it is made fast, it is very probable the molder will tear it off, for it is a great convenience for the molder to have this print to place back in the bottom of his mold while dressing it up.

Figs. 38, 39 and 40 represent the core-box for the steam port. Fig. 38 is a side view with the side *A* taken away. The core is swept off on the outside for the length of *x*, but the piece *c* is made to finish the outside, because the core changes from a circular into a straight part, just where it is entering the steam chest. Fig. 39 is an end view of this box, with the end *B* in Fig. 38 taken away. Fig. 40 is a plan view, and will be understood from Figs. 38 and 39.

The exhaust port core-box is made in halves; one-half is shown in Figs. 41 and 42; the other half is, of course, like this, except that it is made the opposite hand, so that the two halves shall fit when put together. The dotted line in the end view in Fig. 42 shows how the passage is widened to maintain the same area throughout; that is, it is cut down along the part in the direction of arrow in Fig. 41.

The steam chest core-box is made as seen



PATTERN MAKING.

in Figs. 43, 44 and 45; the side and end are taken off in Figs. 43 and 44, to show the inside; the piece *D* that forms the valve face is screwed on the bottom, and the sides fit over it; this core is the first that is set in the mold, then the exhaust and steam port cores are set into 1, 2 and 3, Fig. 45.

Spanish Competition in the Iron Trade.

There are more shipments of crude iron arranged for to be sent from Spain to the northeast of England, as is shown by the lists of charters; and the fact is suggestive of a growing competition in the pig-iron trade under peculiar conditions. Hematite iron is largely smelted in this country from Spanish ores, so that at the first sight it would seem that the importation is merely in the form of pig-iron instead of being in the ore. But the iron made in Spain is smelted with British fuel; and thus any competition that there is resolves itself into the question whether it is cheaper to carry the iron ore to the coal or the coal to the iron ore. It is a proof of how cheaply sea carriage is effected, when it is stated that the cost of the carriage of the coke is at the rate of perhaps 6s. per ton from the port to the port, whilst the iron ore costs perhaps 5s. 4d. per ton for the sea carriage. In either case the land carriage is to be added, but it is to be remembered that our smelters have to pay for a larger tonnage of ore for a given quantity of pig-iron than the Spanish smelters have for coke. The importations are small, too, of pig to the quantity that is smelted here; but still the fact that it is possible to send iron from Spain into this country is one of the proofs that there is and will be a growing international competition in the crude iron trade. Cheap labor and low royalties in Spain enable that country to produce at a very low cost, even when it is remembered that the fuel is carried long distances; and if this country is to retain its ascendency in the iron trade it will have to turn its attention to some of the elements in the cost of production that have scarcely been touched of recent years. There are now experiments being made as to the enlargement of the output from the blast furnaces that may tend in the right direction, and it is probable that the result of legislation now in progress may help to reduce the cost of land transit, but there are other elements in the cost that are little touched—the elements of royalty, of local taxation, as well as the very important one of wages. The cost of the coke, too, is being brought down, though perhaps the fall has been less rapid than that of the decrease in the price of the iron; but any gain from this source is one that would be common both to the home and the foreign smelter who draws his fuel supplies from us. On the other hand, any reduction of the cost of producing iron ore in Spain would benefit us, and the prices in the market of the stocks of those British companies which own mines in Spain show that they find the adventure very lucrative. The difficulty is one that is more of the future than of the present, for the production of pig-iron in Spain is not yet on any scale of magnitude, but it will enlarge as time passes on; and it will interfere with our sales in non-producing countries more than with the consumption in our own. But the fact that the country of the Dons is able to send pig-iron, even to the extent of a few thousand tons, to this country, is one that is worth reflecting on, and one that will claim increasingly the attention of producers here.—*The Engineer* (London).

Making Watch Glasses.

In the manufacture of watch glasses, the workman gathers with the blowing tube several kilograms of glass. Softening this by holding it to the door of the furnace he puts the end of the tube into communication with a reservoir of compressed air, and a big sphere is blown. It is, of course, necessary to get the exact proportion of material at the commencement of the operation, accompanied by a peculiar twist of the hand, and an amazing skillfulness.

The sphere ought to be produced without rents, and in such dimensions that it is of the requisite thickness. Out of these balls the workman cuts convex disks of the required size. This is a delicate operation. A "tournette," a kind of compass furnished with a diamond in one of its branches, is used. The diamond having traced the circle, the glass is struck on the interior and exterior sides with a stick, and the piece is detached. The disks, which are afterward traced, are obtained very easily. They are seized by the thumb, passed through the aperture already made, and detached by the pressure of two fingers. An able workman will cut 6,000 glasses a day.—*Pittsburgh Dispatch.*

The soaps used for cleaning metal work usually consist of mixtures of vaseline, oleic acid and fat, mixed with a small quantity of rouge. When freshly prepared, they leave nothing to be desired; but, unfortunately, such mixtures soon turn rancid and become unfit for use. A new soap for metal work, which is stated to be free from this objection, is made from cocoanut butter in the following way: 2.5 kilos. of the butter are melted in an iron vessel, together with a little water, and to the mixture is added, with constant stirring, 180 grms. of chalk, 87.5 grms. of alum, 87.5 grms. of cream of tartar, and 87.5 grms. of white lead. This mixture is then poured into molds and allowed to solidify. The *Chemical Trades Journal* says the soap so obtained is made into a paste with water, and rubbed over the metal to be cleaned, and finally removed by a dry rag or chamois leather.

The *Manufacturers' Gazette* seems to have made the discovery that "there is a prevailing idea that a blacksmith is anything but a skilled workman," and on this supposed discovery proceeds seriously to prove, as though it were a matter actually needing proof, that the blacksmith is really a skilled artisan. This is simply an effort to prove what no one, so far as we are aware, has ever thought of denying, blacksmiths having been regarded from the earliest days of metal working as being among the most skillful of mechanics.

Southern lumbermen have for some time been dissatisfied with prices, so an enormous trust is in process of formation. It is understood that the usual "freezing out" process will be resorted to in disciplining recalcitrant lumbermen and small dealers generally.

Secretary Raymond announces that the next meeting of the Institute of Mining Engineers will be held at Cleveland, Ohio, beginning Tuesday, June 2.

The loss, by abrasion, on every $1,000,000 in gold coin shipped across the Atlantic, is said to be between one and two thousand dollars.

Machinists' Supplies and Iron.

NEW YORK, May 9, 1891.

Iron—American Pig—Some improvement is noticeable in the general tone of the market, and the prospect for business seems somewhat better.

We quote: No. 1 Foundry, Standard Northern brands, $17 to $18; No. 2 is selling at $16 to $17, and Gray Forge at $14 to $14.50. Southern brands of good quality are obtainable at $16 to $17.50 for No. 1 Foundry; and $15.75 to $16 for No. 2; and $14 to $14.50 for No. 3.

Scotch Pig—We quote at $24.50 for Coltness; $22 for Dalmellington; and $20.50 for Eglinton.

Copper—Very little is being done, and there is apparently little or no interest taken by dealers. Prices of Lake are nominally 13½c. to 14c.; Arizona Ingot, 12¾c. to 13c.; casting brands, 11¼c. to 11½c.

Lead—Comparatively little business is being done, though prices are firmly maintained. Spot supplies range in price from 4.20c. to 4.30c.

Spelter—Prices are nominal at about 4.85c. Little business is being done.

Tin—The market is quiet, but prices are firmly maintained. Spot rules at 19.90c. to 19.95c.

Antimony—The market is somewhat unsettled.

We quote Hallett's, 15¼c. to 15¾c.; Cookson's, 16¾c. to 17c.; and 15¾c. for X. L.

Lard Oil—The market is unchanged at 55c. to 55½c. for Prime City, according to holder and quantity.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 80 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Agents in every shop for fine tools; big inducements. Address E. G. Smith, Columbus, Pa.

Wanted—An experienced and skillful mechanical draftsman. Address Draftsman, AM. MACHINIST.

Iron founders and machinists' bookkeeper, exp., prac., seeks sit'n. Harris, 133 Huntington St., Bklyn.

Wanted—Position as pattern maker and draftsman, by a young man; have had seven years' experience. G. S. L., AMERICAN MACHINIST.

Wanted—Situation in Conn., by an inventor, mechanical draftsman; 18 years exp. at general mach. work. A 1 reference. D. C. S., AM. MACHINIST.

Wanted—Situation by a mechanical draftsman, who has had considerable experience in the shop; A1 references. Draftsman, P. O. Box 990, Hartford, Ct.

A comp. mech. eng. and draftsman will be open for engagement about June 1st. Thorough in designing compound engines and general mach. Well up in electricity. BOX 87, AMERICAN MACHINIST.

Wanted—First-class pattern makers at once; none but experienced men need apply; steady work and good wages guaranteed. Address George J. Cory, Sparrow's Point, Maryland.

Wanted—First-class moiders at once; steady work and good wages guaranteed; men are wanted for loam, dry sand and green sand work. Apply, or address James Powers, Sparrow's Point, Md.

Wanted—A first-class machinist, experienced in light brass, iron and tool work, experimental and jobbing, etc., and of good habits; don't answer unless fully competent. Minneapolis Brass and Iron Mfg. Co., Minneapolis, Minn.

Wanted—A thoroughly practical and skillful machinist to take charge of, and keep in running order, the machinery of a large factory; must be competent to improve on present machinery and methods of doing work. Practical. AM. MACHINIST.

Wanted—Position as foreman by a practical draftsman, experienced in designing, and superintending the construction of jigs and tools for interchangeable work, and in building automatic machinery; good pattern maker. Executive, AM. MACH.

Wanted—By mining company in Mexico, first-class molder; man that is capable of mixing charges and able to run cupola; location very healthy; engagement for four months. Address, giving particulars, reference and terms, BOX 89, AM. MACHINIST.

Wanted—At Pittsburgh Locomotive Works, Pittsburgh, Pa., a competent foundryman to take charge of iron and brass foundries; must be active, entirely temperate, and thoroughly understand locomotive work; state salary expected, and give references.

Wanted—Position as superintendent by machinist and tool maker; 20 years' experience; accustomed to handle men; state the class of work that will be expected, and salary to the right man; references. BOX 90, AMERICAN MACHINIST.

Wanted—A pattern maker, who is acquainted with saw-mill machinery; also, a young man who is acquainted with drafting; must be well educated, and know something of saw-mill machinery; his duties will be part office work as well as drafting. Address BOX 91, AMERICAN MACHINIST.

Wanted—A good tool maker and general machinist—one capable of designing and making tools for screw machines, for the cheap manufacture of set, cap and special screws, etc. Apply, giving references as to ability, character, etc., and stating salary, to BOX 88, AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d hd-lathes & planers. S. M. York, Clev'd, O.

All sizes punch presses & dies. R. T. Lane, Clev'd, O.

Special wire mach'ry. Amer. Tool Wks., Clev'd, O.

Just out: aluminum steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

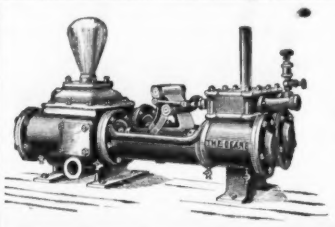
Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Wanted—Specialties to build for the Southern trade. Bluefield Iron Works, Bluefield, W. Va.

A mechanical engineer (mem. A. S. M. E.) with office in New York, desires to represent the manfr. of some good specialty. A. S. M. E., AM. MACH.

I have the best facilities for manufacturing heavy special machine; willing to put money in some machine of merit. S. Hartley, 245 N. J. R. R. Avenue, Newark, N. J.

Wanted—Engineers to write for catalogue of all the latest and most valuable mechanical, scientific and electricdl books which are given free with each barrel of the Pittsburgh Boiler Scale Resolvent. Pittsburgh Boiler Scale Resolvent Co., Pittsb'gh, Pa.



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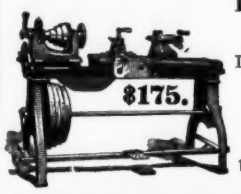
OF HOLYOKE
STEAM PUMPS
DEANE STEAM PUMP CO.,
HOLYOKE, MASS.

CRESCENT STEEL CO'S
Pittsburgh, Pa.
Chicago, Ills.
New York, N. Y.
MAKERS OF
FINE STEEL
For Dies, Punches, Taps, Reamers, Cold Chisels, Lathe Tools, Shear Blades, Milling Cutters, Etc., Etc.



Improved Screw Cutting Foot and Power. LATHES
Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
THE SEBASTIAN-MAY CO.,
167 to 175 Highland Avenue, SIDNEY, OHIO.
MONTGOMERY & CO., 105 Fulton St., New York, Gen'l Agents.

TOBIN BRONZE
Tensile Strength upwards of 79,000 lbs. per sq. in.
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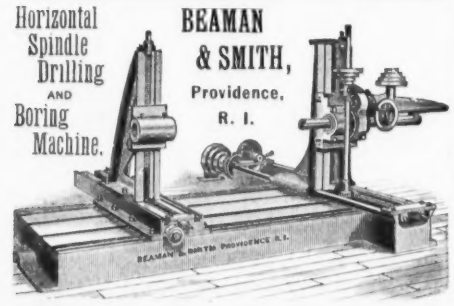

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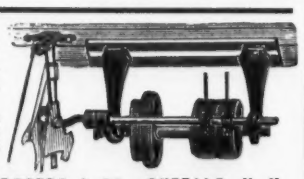

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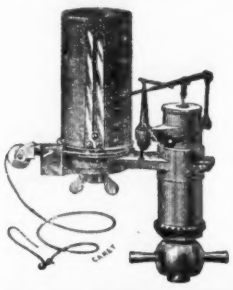

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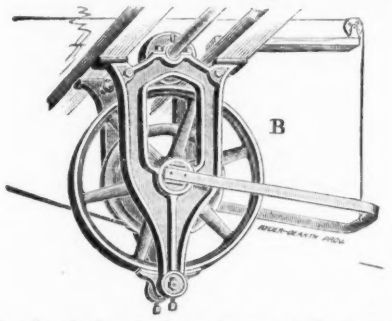

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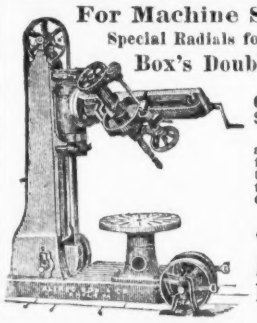

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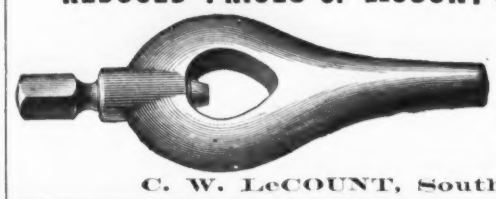

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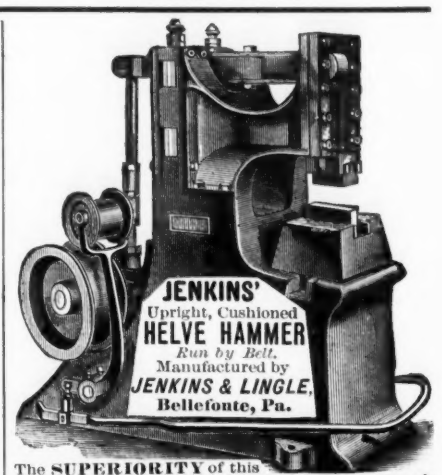

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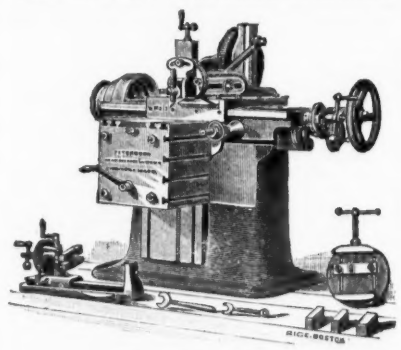

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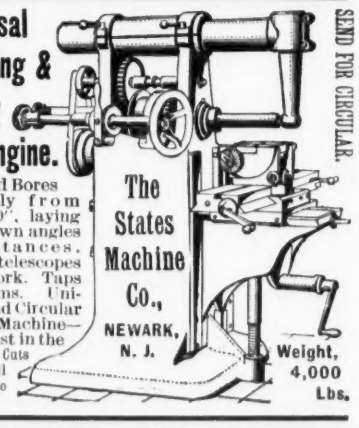

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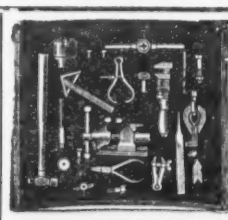

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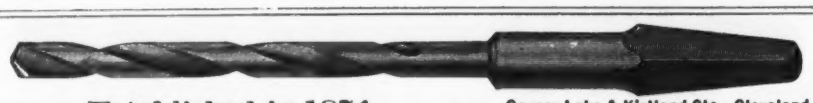

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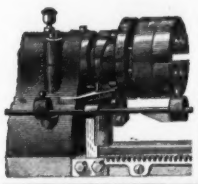

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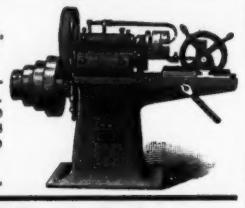

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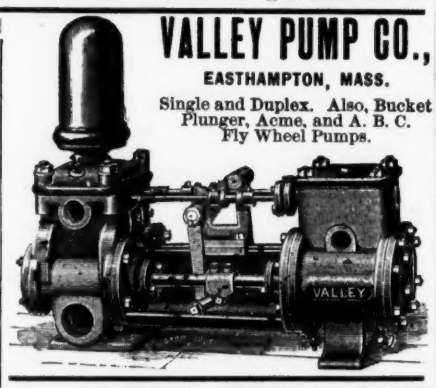

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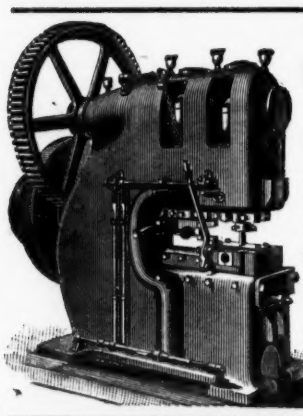

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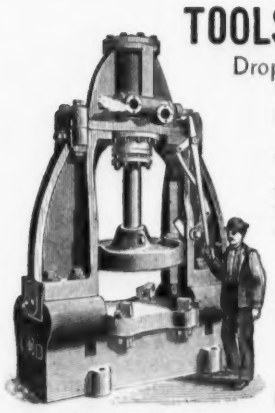

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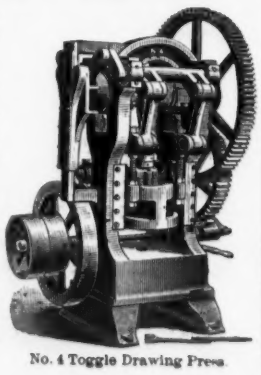

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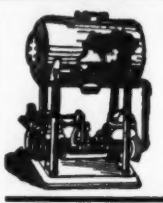

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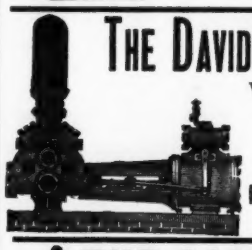

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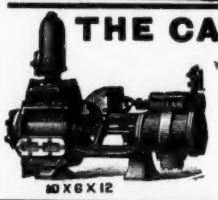

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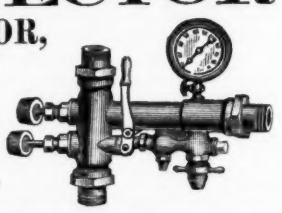

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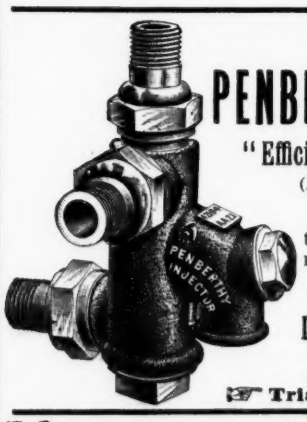

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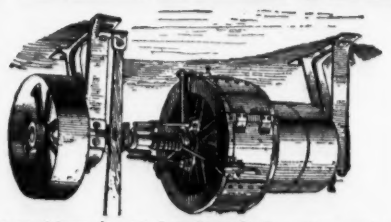

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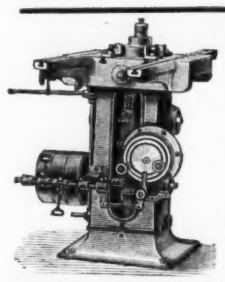

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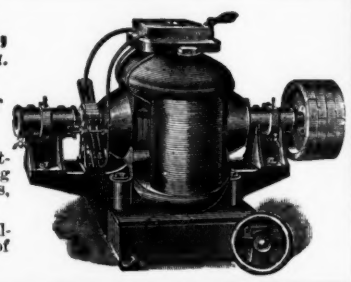

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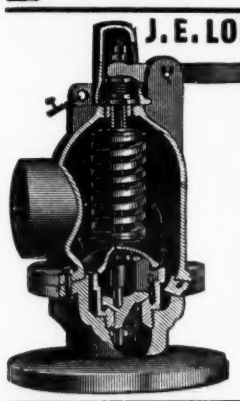

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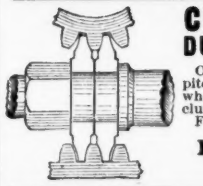

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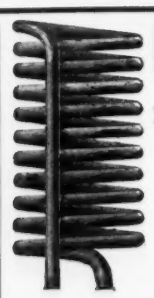

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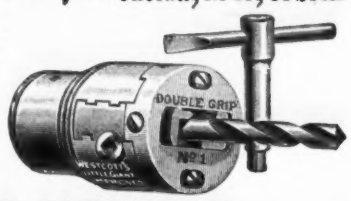

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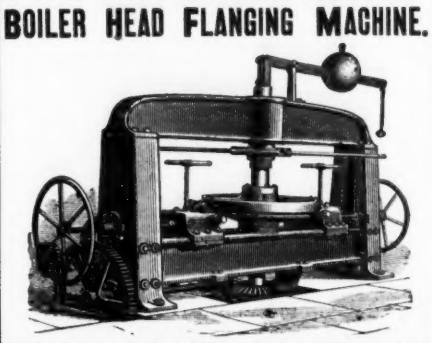

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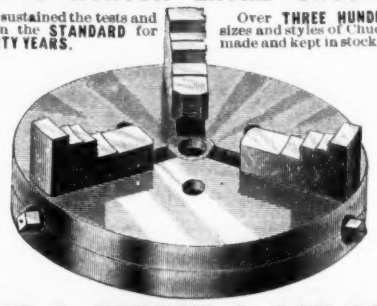

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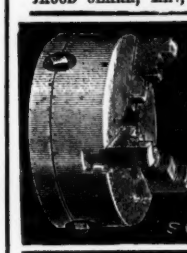

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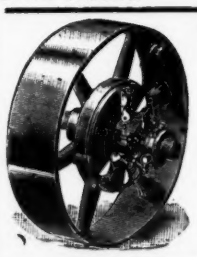

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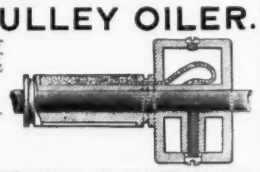

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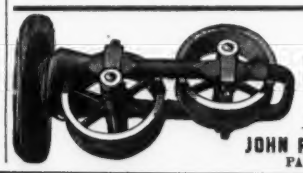

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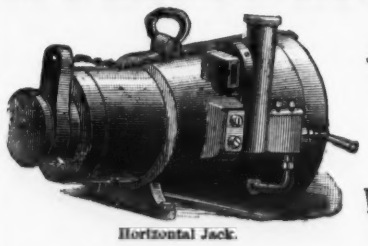

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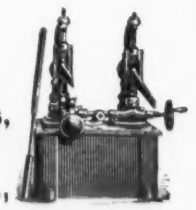

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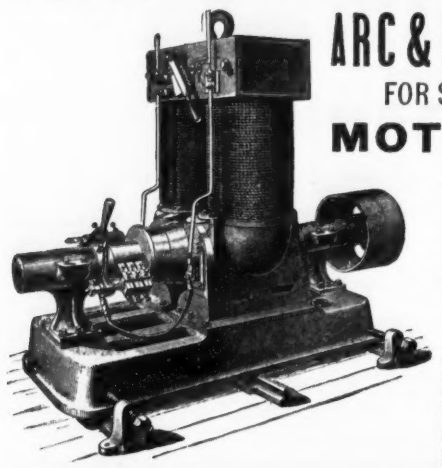

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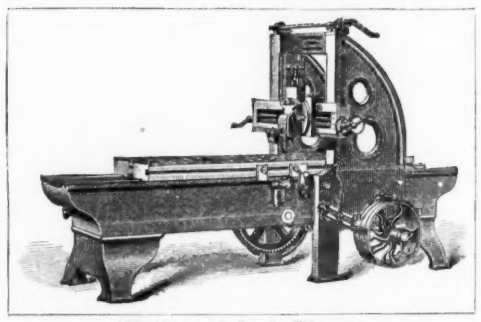

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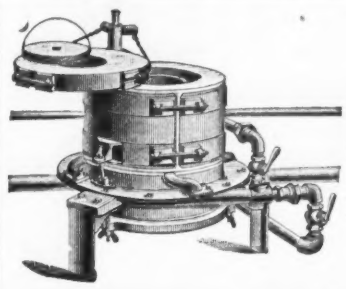

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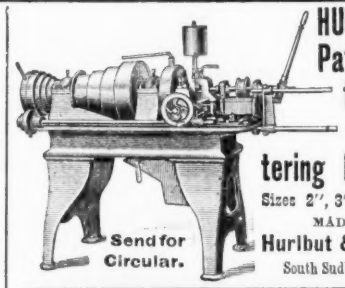

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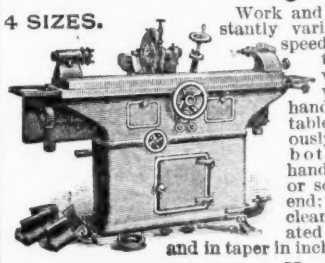

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Portable Key-Way Cutters and Portable Planers a specialty, ranging in size and capacity from the smallest work to key-ways 5 ft long and 6 ins. wide. Over 150 machines in use in the leading shops of this and other countries. For further information address
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"We have no machine in our works of same cost that earns as much money as yours." EDW. P. ALLIS & Co.
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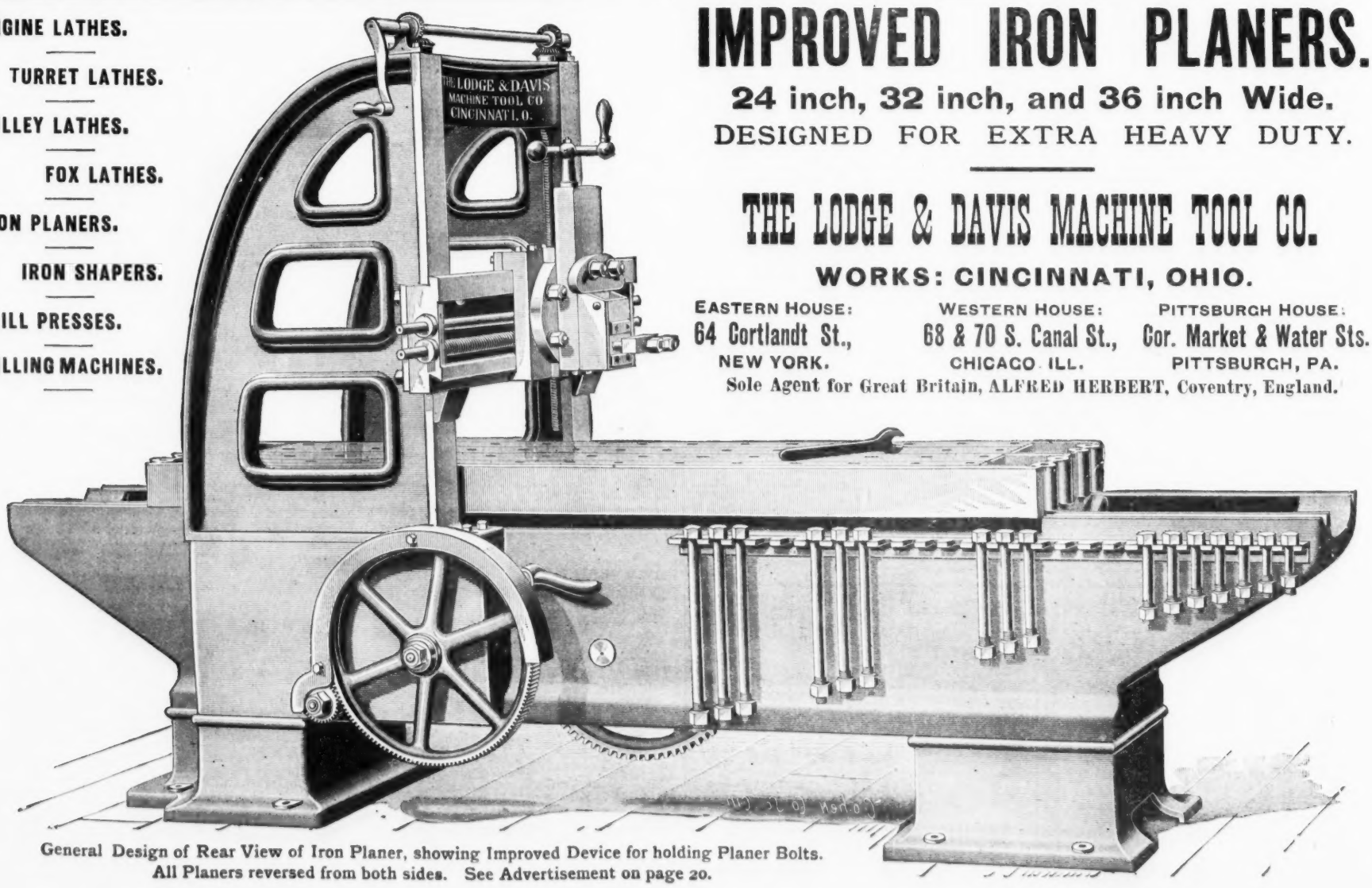

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24 inch, 32 inch, and 36 inch Wide.

DESIGNED FOR EXTRA HEAVY DUTY.

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Sole Agent for Great Britain, ALFRED HERBERT, Coventry, England.

General Design of Rear View of Iron Planer, showing Improved Device for holding Planer Bolts.
All Planers reversed from both sides. See Advertisement on page 20.

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Manufacturers of Morse Patent Straight-Lip Increase Twist Drills. New Bedford, MASS.

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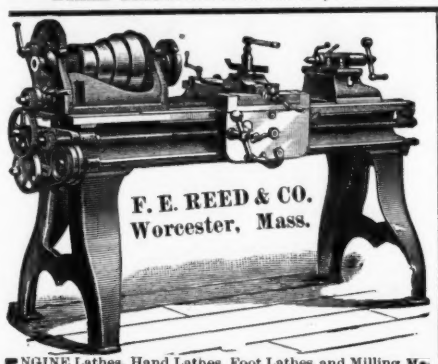

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ANY LENGTH OF BED DESIRED.

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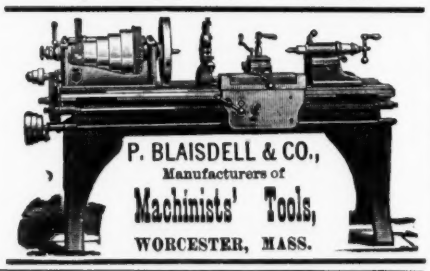

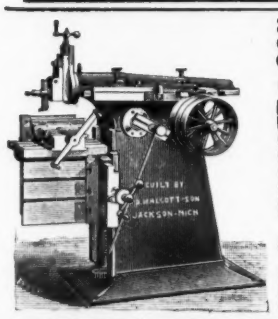

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Something New!!

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Manufacturers of and Dealers in
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IMPROVED PATENT IRON PLANERS A SPECIALTY.
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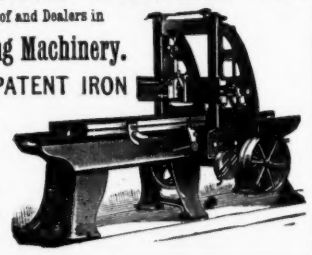

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Very truly yours,
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2 INCH SPINDLE.
Weight, 1100 Lbs.
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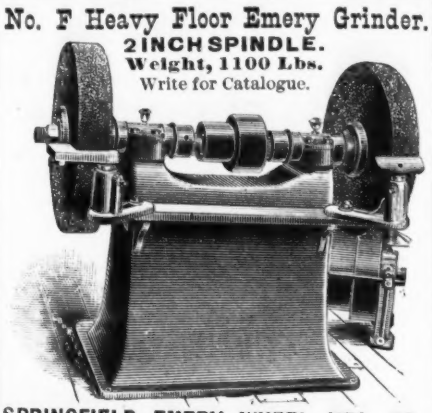

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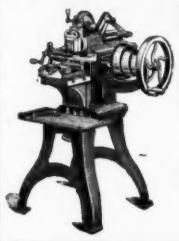

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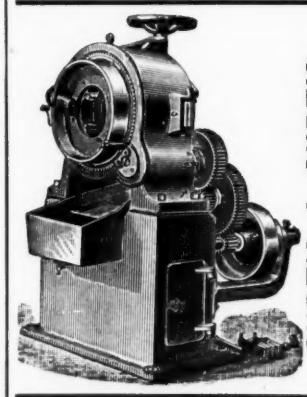

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Pipe Cutting & Threading Machinery,
FOR HAND OR POWER.
RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES.

BARNES' PATENT UPRIGHT DRILLS.

20 to 42 inch swing, with both worm and lever feed, self-feed and back geared
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Sensitive Drill. Single and Multiple Spindle.
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15 inch swing, 6 foot or 8 foot bed.
They have advantages not found in other machines in this line. It will pay parties desiring to purchase or know more about these machines to send for full description and prices to
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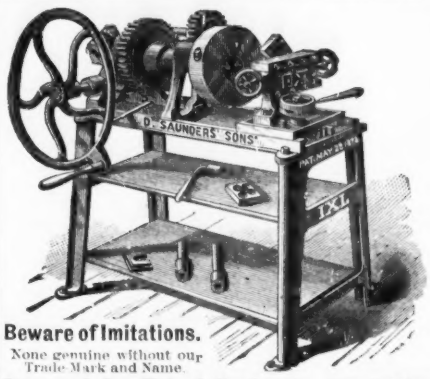

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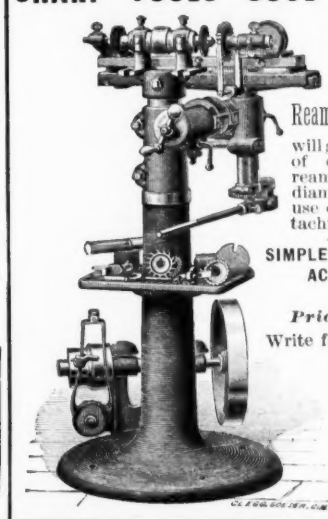

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SIMPLE, ACCURATE, RAPID.
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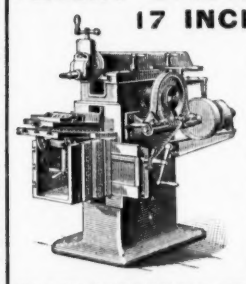

Double racks allowing shaft 2½ to pass through base. Adjustable table for taper work, swivel jaw vise, feed adjustable while running, driven by hardened steel worm in phosphor bronze wheel; smooth running, powerful, durable.

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CONTRACT, JOB, OR DAYS' WORK.

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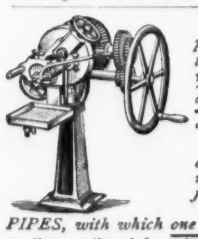

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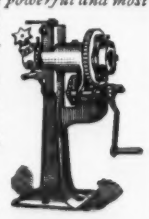

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No. 3 " " " 2½ to 6 in.
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We also build Power Machines.

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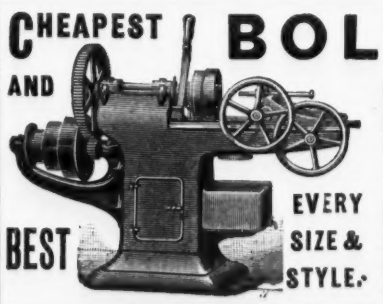

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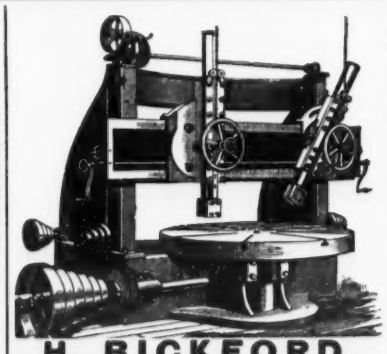

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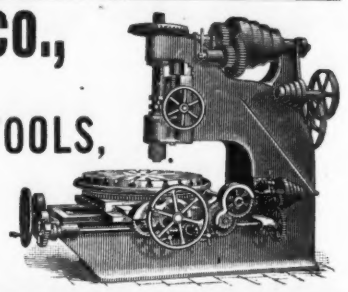

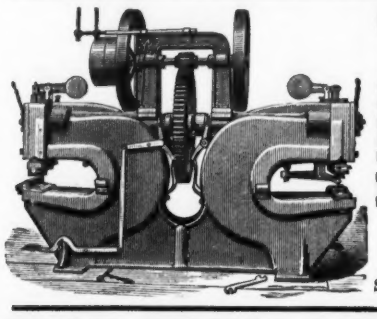

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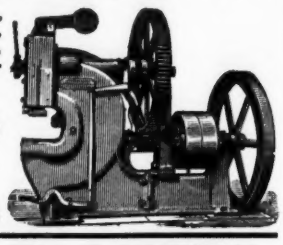

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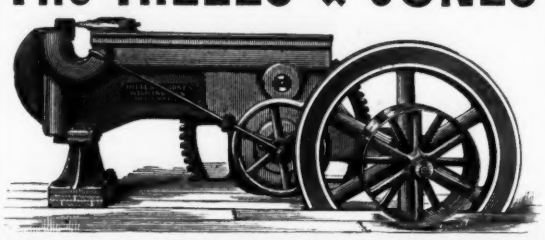

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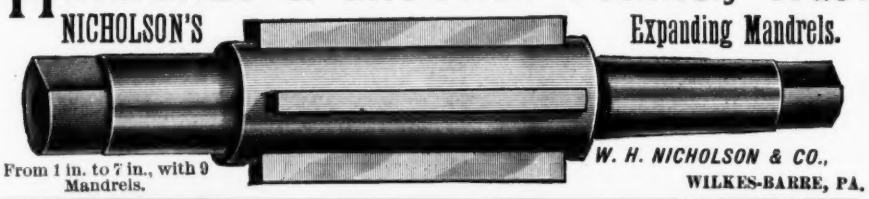

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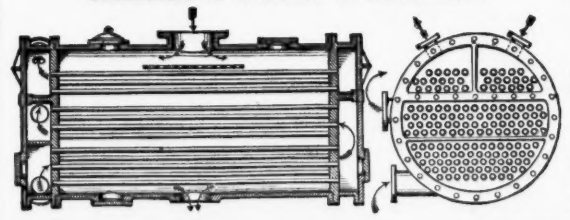

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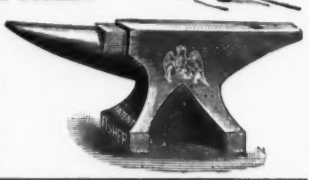

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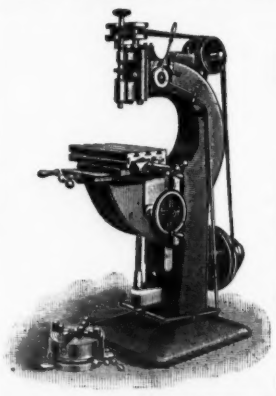

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An indispensable Tool in any well appointed machine shop.
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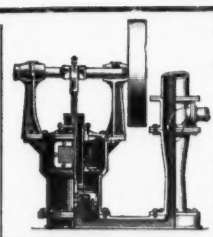

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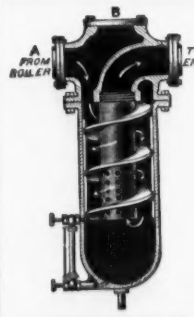

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Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
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PATENTED.
With or without board.
The best and most convenient Drawing Table in the world.
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HUGO BILGRAM,
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Maker of all kinds of
MACHINERY.
Special facilities for Accurate Work.
Bevel Gears cut theoretically Correct.

CHEAPEST AND BEST
THE WATER-TUBE FEED-WATER HEATER
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THE COUBERT MFG. CO.
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NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES

In Use, Over 2,500.

25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for Driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

SALES AGENTS: W. L. SIMPSON, 10 TELEPHONE BUILDING. N. W. ROBINSON, 154 Washington St., Chicago, Ill. 18 CORTLANDT STREET, N. Y. ROBINSON & CARY COMPANY, St. Paul, Minn.

KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland, and Virginia

THE ALBANY STEAM TRAP Co

RENEWABLE SEAT, GATE, STOP AND CHECK VALVES

ALSO MANUFACTURERS OF

"DUPLEX WATER FILTERS," "BOILER PURIFIERS,"

"RETURN STEAM TRAPS," "STEAM PUMPS,"

AND

"PUMP GOVERNORS."

SEND FOR CIRCULARS

ALBANY STEAM TRAP CO. ALBANY, N.Y.

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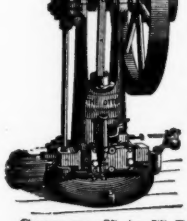
New York Agency, 18 Vesey St.



35,000 SOLD.

Many New Improvements

FOR USE WITH

COAL GAS, NATURAL GAS, PRODUCER GAS, OR GASOLINE.

COMBINED

"OTTO" GAS ENGINES AND PUMPS.

Consume 25 to 75 Per Cent. Less Gas than ANY other Gas Engine doing the same work.

GASOLINE ENGINES

SMALL, BUT HUSTLERS.

A 6 x 7 inch Engine, weight 800 lbs., runs 100 feet of shafting and machinery for twenty machinists on 6 gallons of gasoline, costing only 60 cents per day. Write for particulars. Mention this paper.

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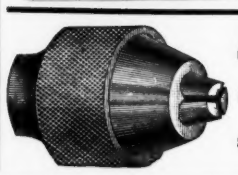

Almond Drill Chuck

Sold at all Machinists' Supply Stores.

T. R. ALMOND,

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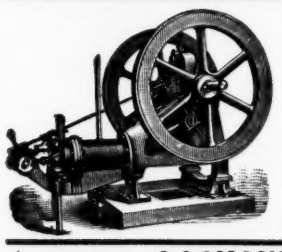

ATKINSON CYCLE GAS ENGINE.

Four strokes of piston in one revolution of crank-shaft, expanding the charge to more than the original volume, driving out *all* the products of combustion, and giving a working stroke at every revolution and in half the time required by any other engine. *Send for Illustrated Circular.*

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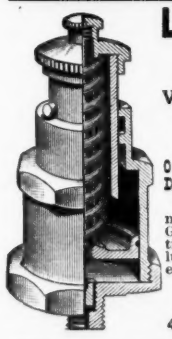

LACKAWANNA GREASE CUP

Will Save its Cost in Oil alone Several Times per Annum.

SAVES ALSO IN LABOR AND COST OF COTTON-WASTE. PREVENTS DRIPPING AND SPATTERING.

A POSITIVE FORCE FEED with the most PERFECT REGULATION and GREATEST CONVENIENCE in operation yet attained in any device for the lubrication of machinery. Works equally well in every possible position.

Lackawanna Lubricating Co.,

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IN STOCK.

FITCHBURG MACHINE WORKS,
Engine Lathes, "New Patterns."
14x6 ft., 16x6-8 ft., 18x8 ft., 24x12 ft.
Planer, 24x6 ft., Shaper, 14 in., Drills, 30-36 in.

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Lathes, 12x6 ft., 15x6 ft., 17x6-8 ft., 18x8 ft.
Drills, 20-21-25 28-32-36 in. swing.

POWELL PLANER CO'S,
Planers, 24x6 ft., 30x8-10 ft., 36x10 12-14 ft.

HENDEY MACHINE CO'S,
Lathes, 14x6, 16x6, 18x6-8-10 ft.
Planers, 16 in.; Shapers, 15-24 in.

SECOND-HAND AND NEW.

Niles Screw Machine, 1¾ in. hole,	good order
Powell Planer, 24x24x6 ft.,	" "
Walters Planer, 24x24x5½ ft.,	" "
Gang Drills, 3 Spindle,	" "
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Brown & Sharpe Screw Mch. wire feed	" "
Lincoln Milling Machines,	" "
Universal and Standard Milling Mchs,	new patterns
Ames Engine Lathes, 13x6 ft., ¾ in. hole,	new
Fay & Scott " 28x12 and 16 ft.,	"
Perkins Lathes, 16x8 ft., 22x10 ft., 24x12 ft.,	"
Shapers, 15 in. Crank motion,	"

Send for Complete List and Special Catalogue.

J. J. McCABE,

SUCCESSOR TO **E. P. BULLARD'S** N. Y. Mach'y Warerooms.

68 Cortlandt Street, NEW YORK.

Complete Steam Plants,

Engines, Shafting, Hangers, Pulleys and Boilers.

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MACHINE TOOLS

BORING AND TURNING MILLS,
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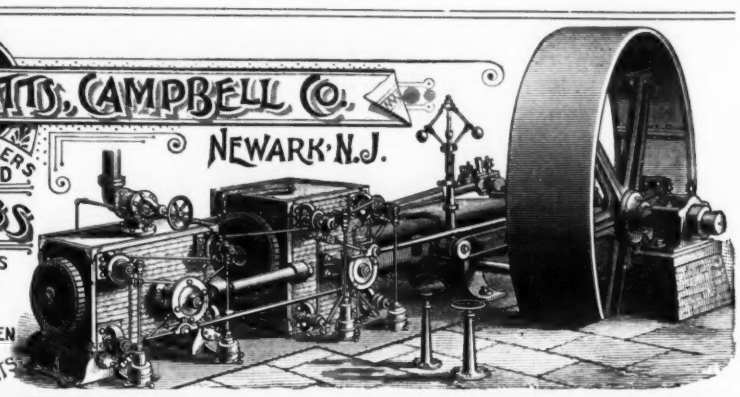

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FRICK COMPANY, Builders.
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NON-CONDENSING,
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40 TO 1,000 H.P.

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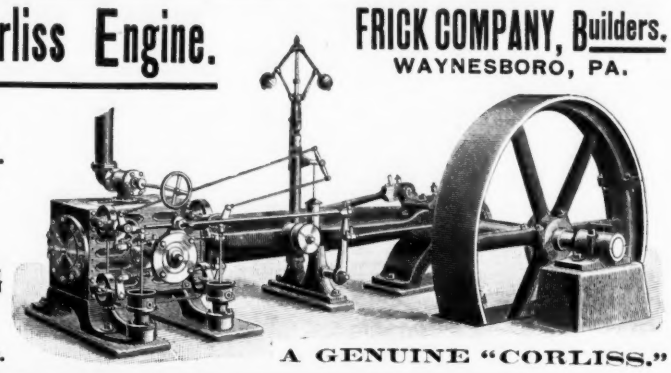

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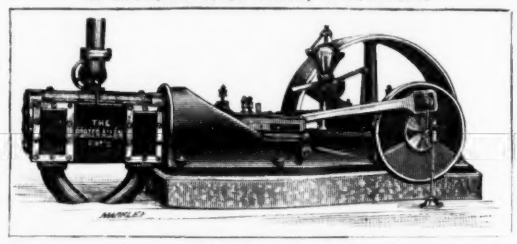

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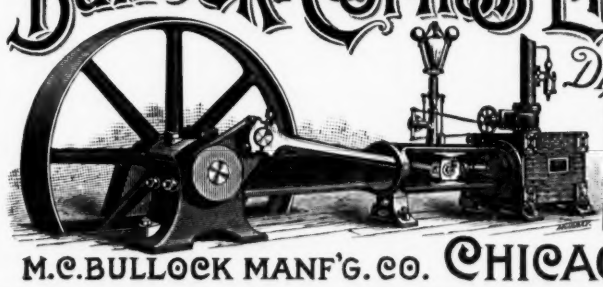
SOLE MAKERS OF

PORTER-ALLEN AUTOMATIC ENGINE.

HIGH ECONOMY. DURABILITY. CLOSE REGULATION.

Bullock-Corliss Engines.



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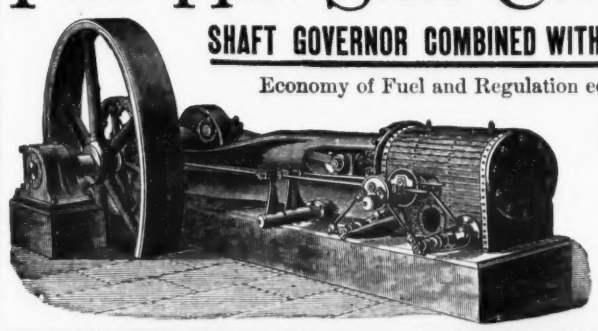
MINING MACHINERY.

M.C. BULLOCK MANF'G. CO. CHICAGO, U.S.A.

PAYNE HIGH SPEED CORLISS ENGINE.

SHAFT GOVERNOR COMBINED WITH CORLISS WRIST-PLATE.

Economy of Fuel and Regulation equal to anything in use.



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PRESSES, DIES AND TOOLS SHEET-METAL TOOLS

FERRACUTE MACHINE CO. BRIDGETON, N.J.

OFFICE, 15 CORTLANDT ST., N. Y. WORKS, ELIZABETH, N. J.

THE BALL & WOOD COMPANY,

BUILDERS OF

Ball Automatic Cut-Off Engines.

SIMPLE, COMPOUND, VERTICAL AND HORIZONTAL.

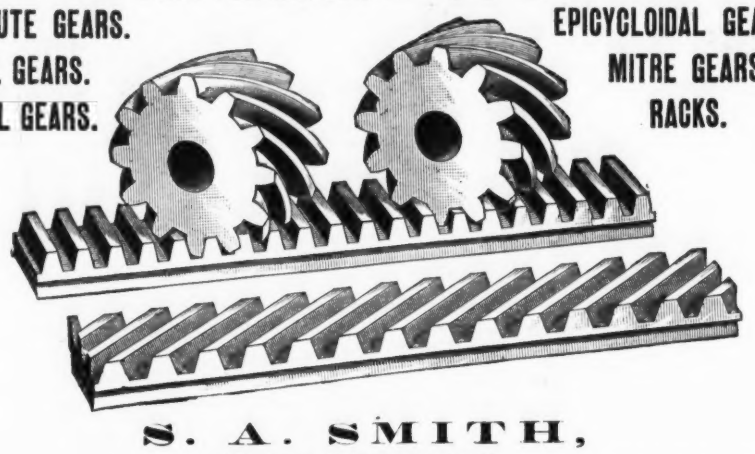
This Company has purchased of MR. FRANK H. BALL, formerly of Erie, Pa., his engine governing and other devices, and is engaged in building and equipping new and modern shops near New York; it will be prepared on June 1st to take orders for Ball Engines, built under Mr. Ball's personal supervision and with his latest improvements.

After May 6th, the business, firm name and good will of CHAS. H. VINCENT & CO., who for the past three years have had the agency of Ball Engines in the East, will be acquired by THE BALL & WOOD COMPANY. Mr. Vincent will become its Secretary, and Mr. Smith have charge of its interests at Cincinnati.

FRANK H. BALL, V. Prest. and Gen'l Manager. **THOMAS C. WOOD,** President.

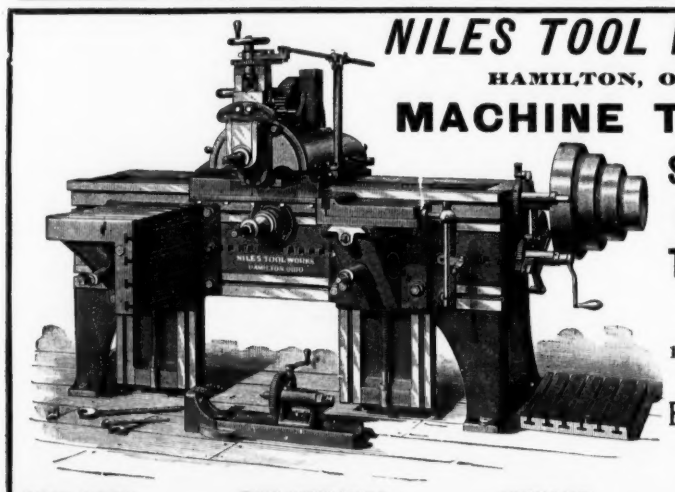
BROWN & SHARPE MFG. CO.,
PROVIDENCE, R. I., U. S. A.

INVOLUTE GEARS.
BEVEL GEARS.
SPIRAL GEARS.
EPICYCLOIDAL GEARS.
MITRE GEARS.
RACKS.



S. A. SMITH,
Western Representative,
23 SO. CANAL STREET, CHICAGO, ILL.

NILES TOOL WORKS,
HAMILTON, OHIO.
MACHINE TOOLS.



SHAPING MACHINES.
TRAVELING HEAD.
16, 18 and 24 inch Stroke.
Extra heavy and powerful.

NEW YORK, 98 Liberty St. PHILADELPHIA, 705 Arch St. CHICAGO, Phenix Building. PITTSBURGH, Lewis Block.

GRANES THE YALE & TOWNE MFG CO.
STAMFORD CONN
NEW YORK CHICAGO PHILA BOSTON

JENKINS STANDARD PACKING will pack a joint, no matter how rough or uneven the surface is.
The action of steam and heat on **JENKINS STANDARD PACKING** softens it, and by following up the joints, fills all cracks, &c. The continued heat on **JENKINS STANDARD PACKING** vulcanizes it, and it becomes hard as, and will last as long as metal itself, for the **JENKINS STANDARD PACKING** does not ROT or BURN OUT. *JENKINS BROS., New York, Philadelphia, Boston & Chicago.*

$150.00 REWARD.

The remarkable increase in the sale of our Improved Machine Tools has induced us to still further place their merits before every user of this class of machinery both in America and Europe.

In order to accomplish this we desire an advertisement out of the stereotyped order.

In view of this fact we will, on July 1st, 1891, pay one hundred dollars ($100.00) for the first and fifty dollars ($50.00) for the second best plan for advertising our line of Improved Tools.

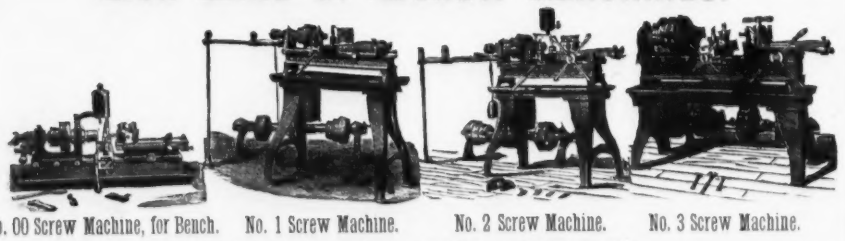
The plans must embody three conditions: First, they must be NOVEL; Second, FEASIBLE; Third, Cost must justify the advertisement being used in large lots.

Competition open to every one, except those in our employ. Communications may be addressed to either of our houses.

Eastern House, No. 64 CORTLANDT STREET, New York City. **The Lodge & Davis Machine Tool Co.,** Works: CINCINNATI, OHIO. Western House, No. 68 & 70 S. CANAL ST., Chicago, Ill.

N. B.—See "Advertisement," page 16.

OUR LINE OF SCREW MACHINES.



No. 00 Screw Machine, for Bench. No. 1 Screw Machine. No. 2 Screw Machine. No. 3 Screw Machine.
Can Furnish with or without Wire Feed.

THE CARVIN MACHINE COMPANY,
Manufacturers of, and Dealers in, all kinds of
MACHINERY AND MACHINE TOOLS.
Universal and Plain Milling Machines, Drill Presses, Screw Machines, Hand and Engine Lathes, Planers, Profilers, Chucking Machines,
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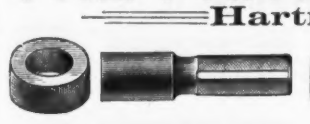
Plants for Manufacturers of Sewing Machines & Electrical Goods.
GEAR-CUTTING AND MILLING IN ALL ITS BRANCHES.
Laight & Canal Sts. [Catalogue sent on Application.] NEW YORK.

THE PRATT & WHITNEY CO.
Hartford, Connecticut.

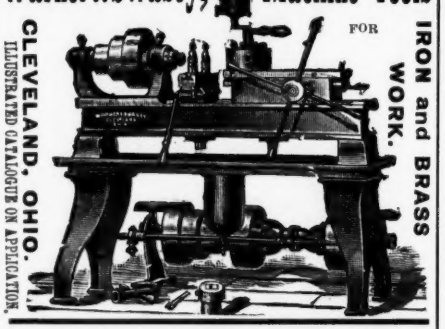


Manufacture Standard Size
Cylindrical and Caliper Gauges,
And End Measure Test Pieces.
Straight and Taper Solid Hand Reamers, Chucking and Shell Reamers, Arbors and Steel Mandrels, Taper Pin Reamers, Combination Lathe Chuck.

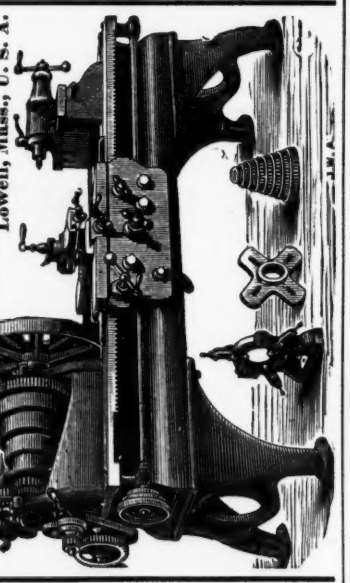
PRICE LIST AND DISCOUNT SHEET SENT UPON APPLICATION.
WESTERN BRANCH, 100 West Washington Street, Chicago, Ills.

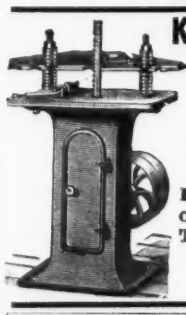
THE BILLINGS & SPENCER CO.,
HARTFORD, CONN., U. S. A.,
MANUFACTURERS OF
BILLINGS' PATENT SURFACE GAUGE.
This Surface Gauge is drop forged, of bar steel, and finished in a thorough manner, and hardened.
Send for Illustrated Catalogue and Price List of Machinists' Tools.
DROP FORGINGS OF BRONZE, COPPER, IRON AND STEEL
OF EVERY DESCRIPTION.

Warner & Swasey, Machine Tools
FOR IRON and BRASS WORK.
CLEVELAND, OHIO. ILLUSTRATED CATALOGUE ON APPLICATION.



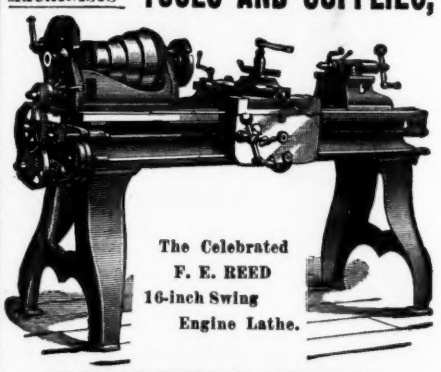
GEO. W. FIFIELD,
Manufacturer of ENGINE LATHES from 16 to 45 in. swing. Cuts, Photographs and Prices furnished on application.
Lowell, Mass., U. S. A.





Key-Seating Machines and 20 in. Drills
A SPECIALTY.
SEND FOR LIST OF
New and Second-Hand
Lathes, Planers, Drills, or anything in Machinists' Tools or Supplies.
W. P. DAVIS,
Rochester, N. Y.

MANNING, MAXWELL & MOORE,
Manufacturers and Dealers in all kinds of
RAILWAY and MACHINISTS' **TOOLS AND SUPPLIES,**



The Celebrated F. E. REED 16-inch Swing Engine Lathe.
111-113 LIBERTY ST., NEW YORK.
We carry the largest line of Tools and Supplies in the City.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

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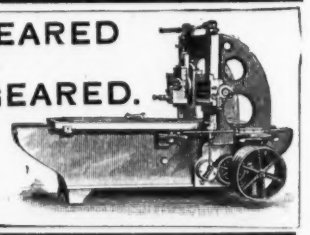
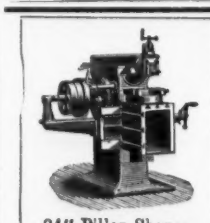
GEAR WHEELS and GEAR CUTTING of every description, all sorts, all sizes, ready made, made to order. Send for catalogue. Send for estimates. Send $1.50 for new Treatise on Gears.
GEORGE B. GRANT, LEXINGTON, MASS.

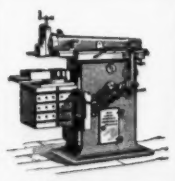
PLANERS SPUR GEARED AND SPIRAL GEARED.
MANUFACTURED BY
The C. A. GRAY CO.,
479 Sycamore St., CINCINNATI, O.





24" Pillar Shaper.

15" Pillar Shaper.



25" Pillar Shaper.

THE HENDEY MACHINE CO.
TORRINGTON, CONN.
MANUFACTURERS OF
MACHINE TOOLS
SEND FOR OUR CATALOGUE.

Manufacturer —of— **TAPS & DIES**